SAVANNAH HARBOR EXPANSION

PROJECT MANAGEMENT PLAN

APPENDIX H

PLAN OF STUDY

Appendix H issued as part of the SHE PMP
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APPENDIX H – PLAN OF STUDY

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I. NEPA TIER II EIS / GRR PLANNING PROCESS OUTLINE

A. Identifying problems and opportunities. Specification of the water and related land resources problems and opportunities (relevant to the planning setting) associated with the Federal objective and specific State and local concerns.

1. Verify/validate the Tier I Problems and Opportunities
    a) Problems – Negative
    b) Opportunities – Positive
2. Verify/validate the Tier I Goals and Objectives
    a) Goal – Doing good broadly (on a macro scale)
    b) Objective – Doing good specifically (on a micro scale).

Used to guide inventory data collection and forecasting, as the basis for formulating alternative plans, guide the evaluation of effects, as a basis for comparing alternative plans, and as a basis for selecting a recommended plan.

3. Verify/validate the Tier I Objectives and Constraints
    a) Objective – Do good
        i) Are – flexible, measurable, attainable, congruent, and supported
        ii) Are not – solutions, absolute targets, the "Federal" objective, or study objective
    b) Constraints – Don't and/or can't do…
    c) Planning Constraints – Universally given and unique to each study
    d) (Endangered species are included in both objectives and constraints)
4. Prepare and advertise scoping process
5. Federal NEPA scoping meeting

6. GRSM - General Reevaluation Scoping Meeting
7. FCA finalize scope of Tier II EIS development

B. Inventorying and forecasting conditions. Inventory, forecast and analysis of water and related land resource conditions within the planning area relevant to the identified problems and opportunities.

1. Forecasting methods – judgmental, quantitative, technological
   a) Informed guess about the future
   b) A future condition or scenario
   c) Anticipates future conditions that are uncertain
   d) Based upon – data, facts, evidence, knowledge, expertise and experience, and assumptions.
   e) Variables to forecast – those that affect decisions
2. Selection Criteria – purpose, reliance of data, level of disaggregation, assumptions, uncertainties and scenarios, short vs long term.
   a) Judgmental methods – individual, group, aggregates
   b) Quantitative methods – time series, explanatory, monitoring
3. Forecast without project condition.
   a) Forecast of the future, without any action to solve the problem at hand. Does not mean “no change” in the future.
   b) Most likely condition or use RBA.
4. Conduct Modeling & Studies
5. Cultural Resources Investigations
6. Channel Borings/Sediment Analysis

C. Formulating alternative plans. Formulation of alternative plans that meet the planning objectives and avoid the planning constraints.

1. Solutions:
   a) Management measure – feature or activity at a site
      i) Feature – structural or requiring some type of construction

ii) Activity – nonstructural/one-time occurrence or ongoing, i.e., continuing or periodic.

iii) Site – land or water, at above or below surface, sufficient legal interest for use

b) Alternative plan – one or more management measures (include beneficial increments)

c) Program – one or more alternative plans

2. Solution interrelationships

a) Combinability – Mutually exclusive location, mutually exclusive function, overlapping

b) Dependency – Required to function, reduce risk or uncertainty of performance, improves performance

3. Formulation phases

a) Identify management measures

b) Document acceptability criteria of Federal “approving” agencies

c) Formulate alternative plans

i) Iterate – “reformulation”

(a) Completeness

(b) Effectiveness

(c) Efficiency

(d) Acceptability

D. Evaluation of the effects of the alternative plans.

1. Look at each of the formulated plans (step 3) on it’s own merits regarding:

a) Completeness – includes all features and costs to realize effects

b) Effectiveness – meet needs, solve problems, achieves opportunities, attains objectives

c) Efficiency – cost effectiveness, i.e.,

d) Cost of plan

e) Opportunities sacrificed

f) All costs (financial, economic, & environmental)

g) Benefits

h) Acceptability

i) Implementable – technically feasible & suites non-Federal interest

j) State and/or local governments standards and/or Federal Standards

2. Evaluation steps (for each formulated plan):

a) Forecast with project condition

b) Compare with plan to without

c) Assess effects – describe and measure effects in terms of:

i) Magnitude Type (NED, EQ, RED, OSE)

ii) Timing and duration

iii) Location

iv) Others

d) Appraise effects

i) Judge impacts

ii) Weigh significance

e) Qualify plans – identify the plans that deserve to be compared against each other.

3. Hold GRR Alternative Formulation Briefing (AFB)

a) Submit Pre-AFB Material to SAD & HQUSACE

b) Conduct AFB

E. Comparing alternative plans. Comparison of alternative plans by contrasting the merits among plans.

1. Criteria for comparision

a) Federal objective

b) Planning objectives and constraints

c) Environmental regulatory thresholds

d) Environmental consultation and coordination requirements

e) Principles and guidelines

2. Comparison Methods
   a) Economic Analysis (Benefit Cost, all effects in $$$)
   b) Cost-effectiveness Analysis (both monetary and non-monetary effects)
   c) Trade-off Analysis (all effects in different units)
   d) Systems Analysis
   e) Net Benefits (optimization)
   f) Incremental Analysis
   g) Risk and Uncertainty
3. Comparison Steps
   a) Compare effects
   b) Describe differences
   c) Describe trade-offs
4. Explicit comparison
   a) Environmental and Social Impact Assessment
   b) Significant Resources and Significant Effects
   c) Regulatory considerations
   d) Project Implementation Timing

F. Selecting a plan. Selection of a recommended plan based upon the comparison of alternative plans.

1. Select Plan
   a) Describe features in detail
   b) Describe mitigation plan in detail
   c) Describe unmitigated environmental impacts
2. Describe implementation responsibilities
3. Determine schedule for implementation

II. <u>MAJOR SUMMARY TASKS</u>

Major tasks for the preparation of the GRR & Tier II EIS include:

A. Scoping Conference – This task includes effort for the participation by HQ and SAD in finalizing the scope for the Tier II EIS.

B. Preparation of the Draft Report – Work tasks include the assembling, writing, editing, typing, drafting, reviewing, reproducing, and distributing of draft reports, environmental documentation, engineering and design appendices as well as other related documentation required for transmittal by the Corps to higher authorities.

C. Independent Technical Review – This task includes preparations for and attending the ITR conference and briefing the ITR team on the draft GRR, Responses to the ITR team's comments will be provided and review comments incorporated into the GRR. An ITR report will be produced, supporting documentation for the GRR.

D. Preparation of the Final Report – This task involves the consolidation of review comments into the final report. Effort includes the rewriting of the main report, review, editing and printing and other costs associated in the preparation of a final GRR.

E. Washington Level Review – By regulation, five percent of the study costs (or $50,000, whichever is less) is set aside to cover expenses incurred by the GPA and the Savannah District during higher authority review.

III. PUBLIC INVOLVEMENT TASKS

A. The Project Managers, GPA External Affairs Office and the Savannah District Public Affairs Office will coordinate this effort. The goal of this effort is to ensure that the public is aware of the study, understands the study process and the need for improved channels and is provided an opportunity to provide comments at critical points in the study.

B. Public Meetings – This task involves the coordination required to inform the public of the study and any related meetings. Work includes a public notice announcing the initiation of the study and requesting the public's input. Additional public meetings will be held at appropriate times during the conduct of the study. It is envisioned that such meetings would occur in conjunction with the AFB and preparation of the draft GRR. Additional public meeting are included as part of the environmental investigations. Effort included here is to write, review, edit, publish and mail the notices.

C. Public Comments Report – This task encompasses conduct of public information sessions and the production of reports covering the sessions. These sessions are designed to obtain information from the public at the initiation of the study. Five sessions are envisioned throughout the Port region. Effort includes the production of poster board, welcome brochures, room fee's, attendance by Corps personnel and a report summarizing the comments received at the sessions.

D. Newsletters – Newsletters are effective means to keep the public up to date on the study progress and allow feedback from the public. A draft quarterly newsletter will be prepared and coordinated with the GPA. The newsletter will focus on recently completed efforts, summarize findings of completed work, and provide the public with an updated schedule, which alerts them to upcoming events. Use of the Internet will also be made.

E. Other Public Involvement Tasks – This task covers other public involvement tasks to ensure the continued coordination with the public. SHE Project website – Internet sites provide an effective and convenient means of conveying information to the public. A Savannah Harbor Expansion Project website will be maintained by the GPA Project Manager for this purpose.

IV. GOVERNING USACE REGULATIONS

A.

V. SCIENTIFIC ANALYSIS & EVALUATION

A. Salinity Distribution Evaluation – Task Code SDE

1. Develop Hydrodynamic & Salinity Model – Task Code SEGDO2

a) Task Goals – This Task has four goals.

i) Refine the hydrodynamic model to include a relationship between surface water and interstitial salinity. The refined model will then be used to directly project the changes in interstitial salinity within the marshes of the Savannah National Wildlife Refuge. It has been postulated in past Savannah studies, that marsh succession is primarily the result of changes in the interstitial salinity. These in turn are driven by salinity changes in the adjacent surface waters. Under the Tier I EIS, relationships developed under the last deepening project were utilized to identify interstitial salinity changes. Based upon comments received, a data collection effort has been proposed to develop this relationship under the present conditions (Task SEGP313). The modeling effort described herein will analyze the data to quantify this relationship and apply it within the existing hydrodynamic model.

ii) Update the hydrodynamic model to include the projection of the temporal and spatial nature of temperature throughout the system. The existing hydrodynamic model does not project temperature, and uses temperature as an input field for water quality simulations.

iii) Reevaluate the 1997 calibration using the revised grid structure developed under Task SEGCL1, and optimized based upon convergence testing. Modification of the grid structure has the potential to alter the solution in the lower harbor, therefore the existing 1997 calibration must be re-evaluated.

iv) Provide verification of the calibrated hydrodynamic model using the in-stream data collected in the summer of 1999 (Tasks SEGP311 and SEGP312). The primary purpose for the summer 1999 data collection effort is to establish the interstitial salinity relationship described above, for calibration of the dissolved oxygen model, and development of the relationship between salinity changes below I-95 to chloride changes at the City of Savannah Intake. But since the hydrodynamics are the base forcing mechanisms for a water quality model, verification to this new data set is necessary.

b) Project Need – Concerns were raised under the Tier I EIS that the relationship between surface water salinity, and interstitial salinity has not been developed under post tide gate conditions. Marsh succession has been identified historically as dependent on the changes in interstitial salinity. Therefore, it is important to provide accurate projections of these changes using the most up to date information. The direct calculation of these changes through the model will provide the data necessary to project the spatial variations in potential marsh succession under the proposed deepening project. One specific request made in the Tier I EIS public comment period, was that a convergence test be performed on the existing hydrodynamic/salinity model. This request was made by USACE under the guidance of the Waterways Experiment Station (WES). WES requested this test to assure that further refinements of the spatial structure would not influence the solution outcome. This will verify that the present spatial resolution is sufficient for the model purposes, and possible allow further optimization of the existing grid structure.

A request was made to evaluate the potential for the sigma grid structure to generate artificial transport. A “dead sea” test will be performed to evaluate this potential. This test is described below.

The dissolved oxygen model is being refined under Task SEGDO1. The hydrodynamic model provides the baseline hydrodynamics to drive the dissolved oxygen model. To properly calibrate the dissolved oxygen model, it is necessary to verify that the salinity model is accurately projecting the hydrodynamic conditions for the data set being utilized (summer 1999). In addition, requests have been made to revisit the turbulence scheme utilized in the model to define if a less site specific application can be developed. If it is found that the more general schemes are unable to simulate the dynamic conditions, the present turbulence scheme will be utilized.

c) Scope – Under the Tier II EIS three specific model development and data analysis efforts will be completed, these are as follows:

- Task SEGCL1: Evaluate Salinity/Chloride Relationship and Develop Chloride Sub-Model
- Task SEGDO2: Refine, Update and Verify Hydrodynamic Model
- Task SEGDO1: Develop Dissolved Oxygen Model

Although distinct in their purposes, these tasks will produce three primary models; the hydrodynamic model, the dissolved oxygen model, and the chloride sub-model. The general progression of work in development of these tools will be as follows. The tasks under which each will be performed are listed:

- Perform convergence test to determine optimized grid resolution below I-95 (SEGDO2)
- Refine the existing model grid above I-95 (SEGCL1)
- Verify accuracy of existing calibration of the hydrodynamic model under the revised model grid using 1997 dataset and revisit turbulence closure scheme (SEGCL1, SEGDO2)
- Verify the hydrodynamic model calibration under the revised model grid using the 1999 dataset (SEGDO2, SEGCL1)
- Calibrate the water quality model using the 1999 dataset with the verified hydrodynamic input from Step 4 (SEGDO1).

To address the issues raised and inputs received to date, this task has been subdivided into the following components:

- Perform convergence test of the existing hydrodynamic model as requested by the USACE Waterways Experiment Station along with Sigma Transport Test.
- Develop interstitial salinity algorithm within existing marsh subroutine and test using 1997 data set.
- Implement temperature component of hydrodynamic model.
- Check model calibration to 1997 data set under the revised grid structure.

- Verify hydrodynamic model against 1999 data set.
- Analyze marsh and in-stream data collected under Tasks SEGP311, SEGP312, and SEGP313 and develop relationship between in-stream salinity changes and interstitial salinity changes.
- Implement relationship developed from data into marsh interstitial salinity algorithm.

d) Deliverables – The deliverable for this task will be a report that summarizes the work performed under the following sections. The report will include all assumptions, methodologies, data analysis, and equations used in the model algorithms as well as all model to data comparisons. In addition, the report will summarize the findings and conclusions from this work task.

i) Perform Convergence and Sigma Transport Tests – Based upon comments received from the Waterways Experiment Station (WES) of the USACOE, ATM will conduct a convergence test of the WQMAP hydrodynamic model. This test will consist of preparation of a coarse grid of the Savannah Harbor System from Fort Pulaski to the I-95 Bridge using the existing grid system as a baseline. This coarse grid will be run under the 1997 tides and flows used in calibration. The output from this coarse grid will then be compared with subsequent runs where the identical grid structure is systematically refined by reducing the horizontal and vertical grid spacing while maintaining identical shoreline geometry and bathymetry. The goal will be to identify the differences in the model solution under the varying grid resolution and to determine the optimum grid resolution for model simulations. The present grid structure will become one of the convergence test runs as the grid is modified.

An additional test will be performed that evaluates whether the sigma stretched grid system is creating artificial transport within the system. The test consists of setting up a stably stratified "dead sea" situation in the system, and running the model with all forcing turned off. The goal is to show that under this condition the model will not produce any artificial flows or transport of salinity.

ii) Develop and Implement Interstitial Salinity Algorithm within Marsh Subroutine – Under this sub-task, the existing marsh subroutine will be modified to provide for a relationship between the projected salinity in the surface waters flooding and drying the marshes, and the temporal and spatial response of the interstitial salinity. The general characteristics will help identify the nature of the relationship, with the exact coefficients being input on completion of the 1999 data collection and analysis.

The data used to develop the interstitial salinity algorithm will come directly from the SNWR and surrounding marshes. This algorithm will be applied to all marshes simulated above old Fort Jackson. Figure SEGDO2-1 shows the extents of the SNWR within the model domain.

The implementation of the algorithm will be completed prior to, and/or in parallel with, the summer 1999 data collection effort. This will expedite the completion of the interstitial salinity projections once data collection is completed and the data analyzed.

iii) Implement Temperature Component of Hydrodynamic Model – Based upon input from agency personnel, it will be necessary to modify the hydrodynamic component of the WQMAP model in order to simulate the spatial and temporal nature of the temperature within the Lower Savannah River. Under this sub-task the hydrodynamic model will be refined to simulate the temporal and spatial nature of the temperature. The model inputs for solar radiation, etc will be derived from the meteorological data collected under Task SEGP312.

iv) Check Model Calibration under Revised Grid Structure – Based upon the convergence tests and the refinement of the grid structure above I-95 described under Task SEGCL1, the 1997 model to data comparisons will need to be reevaluated, and the existing calibration shown to apply under the revised grid structure. Model to data comparisons for this will include:

- Graphical comparison of the model versus data for the tides, currents, flows, salinity, and temperature.
- Longitudinal Plots of Mean Error for the tides, currents, flows, salinity, and temperature.
- Longitudinal Plots of Absolute Mean Error for the tides, currents, flows, salinity, and temperature
- Longitudinal Plots of RMS error analysis for the tides, currents, flows, salinity, and temperature
- Longitudinal Plots of Relative Error for the tides, currents, flows, salinity, and temperature
- Comparison of the primary harmonic constituents calculated from the model results and the data for the tides and currents.

- Graphical and tabular comparison of the measured and simulated mean water level variations (non-tidal lower frequency variations).
- Graphical and tabular comparison of the measured and simulated residual currents (non-tidal lower frequency variations).
- Explicitly form the vertical salinity and temperature difference as a function of time for as many monitoring stations as is possible, and compare this with the model predictions.
- Form the horizontal salinity and temperature difference between adjacent monitoring stations at the surface and bottom as a function of time for as many stations as possible, and compare this with the model output.
- Compare measured and simulated low frequency salinity and temperature variations.
- Compare observations of vertical shear of the horizontal currents with those predicted with the model. Show this as a contour plot as a function of time and vertical height.
- Show some vertical profiles of salinity, temperature, and velocity from the model and from observations.
- Plots of simulated and measured salt flux.
- Plots of horizontal and vertical salinity and temperature gradients.

Longitudinal profiles of statistical errors will be corrected for phase lags to provide a more accurate projection of model magnitude errors. Where phase corrections have been implemented the degree of phase adjustment will be identified.

Additionally, the turbulence scheme, utilized in the Tier I EIS will be revisited to determine if a more general scheme can accurately simulate the dynamic conditions within the Lower Savannah River. If it is found that the more general schemes are unable to simulate the dynamic conditions, the present turbulence scheme will be utilized.

v) Verify Hydrodynamic Model to 1999 Data Set – Under this sub-task, the previously calibrated hydrodynamic/salinity model will be verified against the data collected in the summer of 1999. This will provide the baseline hydrodynamics for the calibration of the dissolved oxygen model. The hydrodynamic/salinity model will be run under the measured offshore tidal conditions, the measured upstream freshwater inflow, and the measured meteorological conditions from the summer of 1999. The model coefficients used in the 1997 calibration will be held constant and the model projections compared against the measured tides, currents, flows, and salinity throughout the system. Figures SEGDO2-2 through SEGDO2-5 present the locations of the stations that will provide data for the model verification. In Figure SEGDO2-5, those stations that will measure both surface and bottom salinity are identified. These locations were taken from the scope of services provided under Tasks SEGP311, SEGP312, and SEGP313.

Model verification will include but not be limited to the following analytical comparisons:

- Graphical comparison of the model versus data for the tides, currents, flows, salinity, and temperature.
- Longitudinal Plots of Mean Error for the tides, currents, flows, salinity, and temperature.
- Longitudinal Plots of Absolute Mean Error for the tides, currents, flows, salinity, and temperature
- Longitudinal Plots of RMS error analysis for the tides, currents, flows, salinity, and temperature
- Longitudinal Plots of Relative Error for the tides, currents, flows, salinity, and temperature
- Comparison of the primary harmonic constituents calculated from the model results and the data for the tides and currents.
- Graphical and tabular comparison of the measured and simulated mean water level variations (non-tidal lower frequency variations).
- Graphical and tabular comparison of the measured and simulated residual currents (non-tidal lower frequency variations).
- Explicitly form the vertical salinity and temperature difference as a function of time for as many monitoring stations as is possible, and compare this with the model predictions.
- Form the horizontal salinity and temperature difference between adjacent monitoring stations at the surface and bottom as a function of time for as many stations as possible, and compare this with the model output.
- Compare measured and simulated low frequency salinity and temperature variations.

- Compare observations of vertical shear of the horizontal currents with those predicted with the model. Show this as a contour plot as a function of time and vertical height.
- Show some vertical profiles of salinity, temperature, and velocity from the model and from observations.
- Plots of simulated and measured salt flux.
- Plots of horizontal and vertical salinity and temperature gradients.

Longitudinal profiles of statistical errors will be corrected for phase lags to provide a more accurate projection of model magnitude errors. Where phase corrections have been implemented the degree of phase adjustment will be identified.

Sensitivity testing will be performed on the hydrodynamic model to evaluate the impacts of variations in key parameters on the projections of hydrodynamic conditions throughout the system. For the hydrodynamic model, the number of parameters available for sensitivity testing is limited. Under this task the following parameters will be evaluated through sensitivity testing:

- Coefficients within the vertical turbulence scheme (i.e. determine the variation in the model solutions based upon alternate definitions of the degree of vertical turbulence).
- Variations in the offshore salinity concentrations.
- Variations in the timing of the freshwater inflow.
- Bottom friction
- Horizontal eddy viscosity

vi) Update Model Marsh Algorithm using 1999 Interstitial Relationship – Utilizing the data collected under Task SEGP313, a relationship between the interstitial salinity and the in-stream salinity that floods the marshes of the SNWR will be developed. This relationship will be implemented within the hydrodynamic model marsh algorithm described under Section 3.1. This will provide an up to date projection of marsh interstitial salinity based upon model projections of in-stream salinity.

2. Alternatives H & S Modeling – Task Code SEGDO3

a) Task Goals – The hydrodynamic and salinity model will be used in conjunction with field data and transfer functions to predict the potential effects for various depth alternatives of the Savannah Harbor Expansion Project on salinity in the Harbor. A plan will be developed and used to conduct the modeling of project effects. The plan will specify the input and output criteria for various model runs.

b) Project Need – The model will be utilized to quantify the deepening effects upon the physical and chemical parameters of concern. These effects will then be correlated to quantify impacts to biological and ecological resources within the Lower Savannah River. Modeling of mitigation alternatives and alternative depths will need to be performed and the levels of impact evaluated and quantified.

c) Scope – Upon acceptance of the model calibration, the models/tools will be utilized to compare the effects of various alternatives upon the physical and chemical parameters of concern. These effects will be used to estimate the magnitude of impacts to biological and ecological resources within the Lower Savannah River. Project alternatives will include mitigation alternatives and alternative depths. Each alternative will need to be simulated under the same input conditions to compare the levels of impact. The number and nature of the model simulations will be determined through an iterative process designed to focus towards a smaller set of the most likely alternatives.

The initial set of screening runs which should be simulated with the hydodynamic/salinity model for the following cases: 42, 44, 46 and 48 ft. depths with normal Spring/Neap tidal cycle and 8200 cfs freshwater flow; 42 and 48 ft. depths for 50 year MSL rise and same as above; and 42 and 48 ft. depths at 4000 cfs and normal tides.

In applying the modeling tools for the evaluation of impacts to natural resources, the determination of the critical conditions, i.e. those conditions under which the effects of the deepening will be felt most severely, will be necessary. The matrix of critical condition scenarios to be evaluated will be developed through the following steps:

- Identification of the parameters to be included in the critical conditions matrix
- Quantification of the historic range of conditions for each of the parameters
- Utilize the models/tools in conjunction with historic data to identify what combinations of conditions reflect the worst case scenario
- Develop the matrix of model runs for effects evaluations

The development of the model effects run matrices should be completed by coordination with a working technical group from the resource agencies.

d) Deliverables – A report of the methodology, assumptions, inputs and results of the model applications will be prepared.

B. Chloride Distribution Evaluation – Task Code SEGCL

1. Develop Chloride Correlation Model - Task Code SEGCCM

a) Task Goals – The overall goal of this Task is to develop the tools to allow for determination of the potential for the proposed harbor deepening to cause an increase in the chloride concentrations at the City's raw water intake. The specific objectives of the Chloride Study are as follows:

- Account for the sources of chlorides to the City's raw water intake.
- Identify the chlorides flowing upstream past I-95 (i.e. caused by salinity intrusion).
- Relate the changes in salinity intrusion within the main harbor to the isolated percentage entering through upstream intrusion.
- Develop a chloride sub-model that will allow the estimation of the change in magnitude and temporal distribution of chloride levels at the City's raw water intake due to the proposed harbor deepening.

b) Project Need – Based upon the proposed deepening project, concerns have been raised about the potential for increased chloride concentrations at the City of Savannah Industrial and Domestic Water Supply raw water intake. The intake shown in Figure SEGCL1-1 is located along Abercorn Creek approximately 1 mile upstream of the confluence of the creek with the Savannah River.

Presently the City is under contract to provide treated water for industrial and municipal use. Under this contract the City must provide treated water with a concentration of chlorides not greater than 12 mg/L. Preliminary evaluation of water samples collected at the intake shows that historically the raw water has had chloride levels in violation of the contracted maximum concentrations. These violations occur primarily during periods of low flow. To date, the industries have dealt with the violations through internal treatment and process modification. The concern raised by the City is that further increases in overall chloride levels may result in significant capital expenditures by the City and the industries.

c) Scope – Under the Tier II EIS three specific model development and data analysis efforts will be completed, these are as follows:

- Task SEGCL1: Evaluate Salinity/Chloride Relationship and Develop Chloride Sub-Model
- Task SEGDO2: Refine, Update, and Verify Hydrodynamic Model
- Task SEGDO1: Develop Dissolved Oxygen Model

Although distinct in their purposes, these tasks will produce three primary models, the hydrodynamic model, the dissolved oxygen model, and the chloride sub-model. The general progression of work in development of these tools will be as follows. The tasks under which each will be performed are listed:

- Perform convergence test to determine optimized grid resolution below I-95 (SEGDO2)
- Refine the existing model grid above I-95 (SEGCL1)
- Verify accuracy of existing calibration of the hydrodynamic model under the revised model grid using 1997 dataset and revisit turbulence closure scheme (SEGCL1, SEGDO2)
- Verify the hydrodynamic model calibration under the revised model grid using the 1999 dataset (SEGDO2, SEGCL1)
- Calibrate the water quality model using the 1999 dataset with the verified hydrodynamic input from Step 4 (SEGDO1).

In order to evaluate the potential for the proposed deepening to impact the chloride concentrations at the City of Savannah Water Intake, it is necessary to try and isolate the potential sources of chlorides. To accomplish this, measurements in the variations in chloride concentrations upstream and downstream of the intake along Abercorn Creek. Measurements will occur, between the Houlihan Bridge and I-95, and along the Savannah River above the entrance to Abercorn Creek. The most upstream measurements will occur near Ebeneezer Creek. The data collection program is outlined in Task SEGP311.

The data collection program was designed to identify chloride inflows from the following sources:

- Flowing downstream from the headwaters
- Flowing upstream from the estuarine portion of the river (due to salinity intrusion)
- Localized inputs from adjacent lands and tributaries

Under Task SEGCL1 the data collected under Task SEGP311, as well as other available data, will be analyzed. From this data analysis a relationship between the intrusion of salinity in the main harbor and the resulting flux of chlorides past the I-95 bridge will be determined. This relationship will be used to project a chloride boundary condition at the I-95 Bridge for use in a chloride sub-model (discussed below). In addition it will be determined to what degree the chloride concentrations at the City of Savannah Intake are the result of salinity intrusion up the Front River at present. If it is determined that the chloride levels at the intake are the result of salinity intrusion, a relationship will be developed between the degree of salinity intrusion and the changes to chloride concentrations at the intake. This relationship will be derived directly from the data collected and will provide verification of the chloride sub-model's ability to project the changes at the Intake.

The hydrodynamic/salinity model will be expanded and refined between I-95 and Ebenezer Creek. This will allow for more accurate projections of the hydrodynamic conditions upstream of I-95 in the area of the City's Intake. Utilizing the salinity/chloride relationship and the refined hydrodynamic model to provide the boundary forcing conditions, a chloride sub-model will be developed upstream of the I-95 bridge. This chloride sub-model will be utilized to project the chloride increases at the City's Intake given the boundary forcing conditions generated from the refined system wide model and the salinity/chloride relationship.

To address the issues listed above, and to address inputs received to date from agency personnel, this task has been broken down into the following 4 components:

- Develop Database of Existing Information
- Analyze Data and Develop Salinity/Chloride Relationship

- Hydrodynamic Model Refinement
- Develop Chloride Sub-Model

d) Deliverables – The deliverable for this task will be a report that summarizes the work performed under each of the sub-tasks listed below. The report will include all assumptions, methodologies, and equations used in the analyses and model algorithms as well as all model to data comparisons used in calibration. In addition, the report will summarize the findings and conclusions from this work task.

2. Alternative Chloride Modeling - Task Code SEGCLCM

a) Task Goals – The chloride sub model will be used in conjunction with the hydrodynamic and salinity model to predict the potential effects for various depth alternatives of the Savannah Harbor Expansion Project on chloride levels at the City of Savannah's water intake in Abercorn Creek. A plan will be developed and used to conduct the modeling of project effects. The plan will specify the input and output criteria for various model runs.

b) Project Need – The models will be utilized to quantify the deepening effects upon chlorides at the City's water intake. Modeling of mitigation alternatives and alternative depths will need to be performed and the levels of impact evaluated and quantified.

c) Scope – Upon acceptance of the chloride model calibration, the model will be utilized to compare the effects of various alternatives upon the physical and chemical parameters of concern. Each alternative will need to be simulated under the same input conditions to compare the levels of impact. The number and nature of the model simulations will be determined through an iterative process designed to focus towards a smaller set of the most likely alternatives.

In applying the modeling tools for the evaluation of potential impacts to the water supply source, the determination of the critical conditions, i.e. those conditions under which the effects of the deepening will be felt most severely, will be necessary. The matrix of critical condition scenarios to be evaluated will be developed through the following steps:

- Identification of the parameters to be included in the critical conditions matrix
- Quantification of the historic range of conditions for each of the parameters
- Utilize the models/tools in conjunction with historic data to identify what combinations of conditions reflect the worst case scenario
- Develop the matrix of model runs for effects evaluations

d) Deliverables – A report of the methodology, assumptions, inputs and results of the model applications will be prepared.

C. Dissolved Oxygen Distribution Evaluation - Task Code SEGDO

1. Develop Dissolved Oxygen Model - Task Code SEGDO1

a) Task Goals – The goal of this task is to develop a calibrated dissolved oxygen model for use in evaluating the impacts of the proposed deepening upon the dissolved oxygen balance within the Lower Savannah River. The dynamic conditions in the estuarine portion of the Savannah River result in a wide range of dissolved oxygen levels. Concerns have been raised that further deepening of the navigation channel may result in lower dissolved oxygen concentrations due to reduced velocities and increased stratification. The model will be needed to evaluate the project impacts under pre-defined critical conditions.

The dissolved oxygen model will be utilized to define the impact of the proposed deepening on the spatial and temporal concentrations of dissolved oxygen within the primary study area. Project effects on dissolved oxygen levels will be evaluated under critical conditions to determine the impact to aquatic species. Although the dissolved oxygen model will extend from Clyo down, for the purposes of this task, the primary study area extends from I-95 to the mouth of the Savannah River below Fort Pulaski, and includes the Middle River, the Back River, the Little Back River, and the South Channel. Overlap will exist between the model developed under this Task and a model being developed by EPA for the upper Savannah River. Figure SEGDO1-1 presents the extents of the system to be modeled under this Task.

b) Project Need – The dissolved oxygen model developed under the Tier I EIS was a simplified model whose purpose was to isolate the net impact of the proposed deepening under a set of representative summer conditions. During the public comment period, concerns were raised as to the capability of this simplified model to more completely address the true impacts of the deepening on the absolute levels of dissolved oxygen under a set of critical conditions. The comments focused specifically on the use of literature values for specific rates, kinetic constants, and boundary conditions, the simplified nature of the model, and the use of representative rather the critical conditions for impact evaluation. The comments focused on the following issues:

i) Quantification of the characteristics and temporal variability of the point source loads within the study area.

ii) Quantification of the total loads entering the estuarine portion of the system from the upstream basin.

iii) Quantification of the influx of loads through the offshore and adjacent tributary boundaries.

iv) Quantification of the interactions between the surface waters and the wide expanse of adjacent marshes in the Savannah National Wildlife Refuge (SNWR).

v) Quantification of the site-specific interaction between the surface waters and the bottom sediments, i.e. sediment oxygen demand (SOD) and benthic flux rates.

vi) Quantification of the site-specific reaeration rates.

vii) The grouping of all oxygen demanding loads into one BODU value rather than isolating the NBODU and CBODU.

viii) The model not accounting for the primary productivity within the system.

Under Task SEGP312 a data collection program has been identified that provides the site-specific data for input into the dissolved oxygen model. The model will be calibrated to this data set. The sufficiency of the data set will be based on the ability to calibrate the dissolved oxygen model, and to appropriately address various causes of oxygen demand, e.g., navigation, point sources, non-point sources, SOD, marsh inputs, upstream loading and dredging for use in evaluating project effects under critical conditions. The model kinetics and inputs will be evaluated through a technical review group to assure that all critical processes have been identified and properly simulated. This will provide an accurate assessment of the impacts of the proposed project on the dissolved oxygen balance within the Lower Savannah River.

c) Scope – Under the Tier II EIS three specific model development and data analysis efforts will be completed, these are as follows:

- Task SEGCL1: Evaluate Salinity/Chloride Relationship and Develop Chloride Sub-Model
- Task SEGDO2: Refine, Update and Verify Hydrodynamic Model
- Task SEGDO1: Develop Dissolved Oxygen Model

Although distinct in their purposes, these tasks will produce three primary models; the hydrodynamic model, the dissolved oxygen model, and the chloride sub-model. The general progression of work in development of these tools will be as follows. The tasks under which each will be performed are listed:

- Perform convergence test to determine optimized grid resolution throughout the system (SEGDO2)
- Refine the existing model grid above I-95 (SEGCL1)
- Verify accuracy of existing calibration of the hydrodynamic model under the revised model grid using 1997 dataset and revisit turbulence closure scheme (SEGCL1, SEGDO2)
- Verify the hydrodynamic model calibration under the revised model grid using the 1999 dataset (SEGDO2, SEGCL1)
- Calibrate the water quality model using the 1999 dataset with the verified hydrodynamic input from Step 4 (SEGDO1).

To address the issues raised and inputs received to date, this task has been broken down into the following components:

- Literature and Historic Data Review to Identify Critical Biogeochemical Processes to be Considered
- Preliminary Model Set-up, Refinement, and Testing using Existing Data
- Analysis of 1999 Data to Verify Critical Biogeochemical Processes to be Considered
- Determination of Model Input Conditions for 1999 Calibration
- Determination of Baseline and Allowable Ranges of Model Kinetic Rates and Constants for 1999 Calibration
- Initial Calibration to Intensive 1999 Data Set
- Model Sensitivity Testing and Refinement

d) Deliverables – The deliverable for this task will be a report that summarizes the work performed under of the sub-tasks below. The report will include all assumptions, methodologies, and equations used in the analyses and results of model simulations including all data comparisons. In addition, the report will summarize the findings and conclusions from this work task.

i) Literature and Historic Data Review to Identify Critical Biogeochemical Processes to be Considered – Under this task the basic processes that will be considered within the water quality component (BFWASP) of the WQMAP system will be identified. Utilizing existing data, as well as past studies performed within the Lower Savannah River Estuary and the upper Savannah Basin, the important processes affecting dissolved oxygen within the Lower Savannah River, will be identified and reviewed through a Technical Review Group.

The processes identified within this task will then be compared with the present kinetics implemented in the BFWASP component of the WQMAP system. Figure SEGDO1-2 presents a diagram of the present kinetic processes within the BFWASP component of WQMAP. Where BFWASP existing kinetics are insufficient to meet the needs identified under this task, an implementation plan, with appropriate kinetic modifications will be prepared and submitted to the Technical Review Group for approval.

Once the list of kinetic modifications have been identified and approved, the BFWASP model code will be modified in order to include the identified changes. Simplified tests, that evaluate the accuracy of the revised processes in the BFWASP model, will be performed. The results from these simplified tests will be presented to the Technical Review Group for approval upon completion. This will be additional work not presently identified within the Scope of Services and costs for Task SEGDO1.

A specific evaluation will be made of the potential for atmospheric deposition to impact the water quality kinetics within the Lower Savannah River Estuary. The potential levels of atmospheric deposition and their relevant impact will be quantified from existing data sources. The impact of this component on the overall dissolved oxygen budget within the water column will be quantified, and, if determined significant, the need for additional information will be identified and evaluated through the Technical Review Group.

ii) Preliminary Model Set-up, Refinement and Testing Using Existing Data – Utilizing the BFWASP model component as modified under Section 3.1, preliminary model tests will be conducted utilizing the data set collected under the Tier I EIS. The goal of this task is to provide a preliminary evaluation of the model performance under the complex kinetics defined in Section 3.1, and to test the model against actual data from the Lower Savannah River Estuary. These runs will only be used to provide preliminary tests of the water quality model, the final calibration will only reflect data collected in the summer of 1999.

The preliminary testing will identify any significant deficiencies in the model, and allow timely correction of these problems prior to the 1999 intensive data set being made available. Performing this task in parallel with the data collection will expedite the final calibration process by allowing the calibration to concentrate upon the determination of appropriate model coefficients and inputs rather than on modifications to the BFWASP model code and model refinements.

In addition, the data post-processing algorithms for statistical and graphical model to data comparisons will be refined under this process. Once again performing this task in parallel with the data collection will expedite the final calibration process.

iii) Analysis of 1999 Data to Verify Critical Biogeochemical Processes and Quantify Measured Kinetic Rates and Constants – An extensive data set is being collected under Task SEGP312 for use in the dissolved oxygen model calibration. Under this sub-task the data set will be analyzed to verify that the biogeochemical processes within the BFWASP model (refined under Section 3.1) are sufficient to represent the system as measured in the summer of 1999, i.e. do the data show any processes not explainable under the present kinetics within the WASP sub-model..

The data will be analyzed to define measured kinetic rates and constants from the 1999 data set for use in the model calibration. The determination of the types of data analyses required will be based on the data characteristics, and these analyses will be presented before the Technical Review Group for review and approval.

iv) Determination of Input Conditions for 1999 Dissolved Oxygen Model Calibration – For the 1999 dissolved oxygen model calibration, the baseline hydrodynamics will come from the verification of the hydrodynamic model identified under Task SEGDO2. The temporally and spatially varying temperature and salinity fields will be simulated within the water quality model as a check on the consistency of the transport schemes between the hydrodynamic and water quality model. The following input conditions will need to be identified based upon the intensive data collection described under Task SEGP312 for the dissolved oxygen model:

- Offshore inflow concentrations of all simulated water quality parameters
- Inflow concentrations of all simulated water quality parameters at internal boundaries

- Inflow concentrations of all simulated water quality parameters across marsh interaction boundaries
- Flux of all simulated water quality parameters between benthic layer and upper water column
- Flux of all simulated water quality parameters across air/water interface

The model input conditions will be prepared based upon the data collected under Task SEGP312. The inputs to be used will be presented to the Technical Review Group for approval prior to commencement of model calibration.

v) Determination of Model Kinetic Rates and Constants for 1999 Calibration – Utilizing the site-specific kinetic rate and chemistry data collected under Task SEGP312, a list identifying the temporal and spatial nature of all the kinetic rates and constants will be prepared. The list will include all rates and constants to be used within the model. Where site specific data are not available, reasonable and appropriate literature values will be determined and listed along with allowable ranges of variation for systems such as the Lower Savannah River. For all literature and site-specific defined rates and constants, a table will be prepare that outlines the initial values and the allowable ranges for use in the model calibration. The allowable ranges will be based upon literature values for similar systems, and will represent the widest range allowable for similar systems. The goal is to provide some boundaries on the coefficients during calibration, although final determination of allowable ranges will come from the technical review process. Where literature values are used rather than site-specific data, these values will be identified as such.

The rates and constants table , along with supporting data and analyses, will be presented to the Technical Review Group for approval as the baseline conditions for the model calibration. Although these values may change during model calibration (as described under Section 3.7), all changes, along with technical documentation for the changes, will be presented to the Technical Review Group for approval.

The one data set that may delay the determination of the full list of kinetic rates and constants will be the long-term BOD measurements. As these are ongoing tests, and results are available as the tests progress, these data will be made available prior to completion of the tests to allow model calibration work to move forward. This will need to be implemented under Task SEGP312.

vi) Initial Calibration to Intensive 1999 Data Set – Utilizing the model input conditions and the model kinetic rates and the defined constants, the dissolved oxygen model will be calibrated to the intensive data set collected in the summer of 1999. The calibration will consist of model comparison to at least 30 days of data collected in the summer of 1999. Under the calibration process, the hydrodynamic model as validated under Task SEGPDO2 will be utilized to drive the dissolved oxygen model. The temperature and salinity in the water quality model will be simulated parameters. The simulations will occur within both the hydrodynamic and water quality models as a check on the consistency of the transport schemes in both models. This check on the tranport schemes will be presented as part of the water quality model calibration.

The initial model calibration runs will be performed with the model kinetic rates and constants as defined. Comparisons of the simulated dissolved oxygen concentrations with the measured values will be made under the initial kinetic rates and constants and presented to the Technical Review Group. Differences between the simulations and data will be identified along with potential reasons or processes affecting the solutions. Modification of site-specific measured rates and constants, outside of the allowable ranges will not be done to more accurately simulate dissolved oxygen concentrations unless technically justifiable. In addition, kinetic rates and constants determined from literature values will not be modified outside of acceptable literature ranges for the water body unless shown to be technically justifiable.

Model to data comparisons will include but not be limited to the following:

- Graphical comparisons of dissolved oxygen time series by station (surface and bottom where data permit)
- Least Squares Regression for dissolved oxygen by station (surface and bottom where data permit
- Vertical profiles of water quality constituents where data are available
- Longitudinal profiles taken as a snap shot in time for dissolved oxygen at various times throughout the simulations
- Comparison of the longitudinal and vertical structure of dissolved oxygen taken from the 10 primary EPD station data.

- Longitudinal profiles of all other water quality parameters measured (see SEGP312 for list) averaged over the simulation period with maximum and minimum values plotted.
- Longitudinal profiles of Mean Absolute Error (MAE) for dissolved oxygen
- Longitudinal profiles of Mean Error for dissolved oxygen
- Longitudinal profiles of RMS Error for dissolved oxygen
- Longitudinal profiles of Relative Error for dissolved oxygen

Figures SEGDO1-3 through SEGDO1-5 present the locations of data collected for model comparison. These figures present the following:

- Locations for the comparison of continuous dissolved oxygen and the discrete chemistry sampling (SEGDO1-3).
- Locations for the comparison of the long-term biochemical oxygen demand (SEGDO1-4).
- Locations for the comparison of the synoptic in-situ monitoring for determination of the longitudinal structure of dissolved oxygen (SEGDO1-5).

In addition to the model to data comparisons listed above for the model state variables, additional information relative to the dissolved oxygen balance within the model, and other calculated variables within the model will be presented to the Technical Review Group. The data will include but not be limited to the following:

- Reaeration rates
- Proportioning of the dissolved oxygen deficit between the SOD, point source BOD and ammonia inputs,upstream inflow of BOD and ammonia, marsh BOD and nutrient inputs, etc.

The final determination of output from the model for presentation will be determined through the Technical Review Group. The initial model calibration, along with supporting data and analyses will be presented to the Technical Review Group for review upon completion.

vii) Model Sensitivity Testing and Refinement – Sensitivity testing of the model will be made by adjusting the various model kinetic rates and constants within the range of values as defined. The results of the sensitivity testing will be presented relative to the impacts of the coefficient variations upon the dissolved oxygen concentrations within the system. The model sensitivity testing will follow the presentation of the initial model calibration to the Technical Review Group and be under their guidance. Under this task the model will be refined and where necessary recalibrated based upon the Technical Review Group input. Upon completion of this sub-task the model will be fully calibrated and tested and ready for use in impact evaluations. Detailed determination of the degree of sensitivity testing will be made by the Technical Review Group and will be based upon analysis of the 1999 data and the model calibration.

Additionally, evaluation of the uncertainty of the model projections relative to the model input parameters will be performed. Determination of the degree of uncertainty analysis will be made by the Technical Review Group and will be based upon analysis of the 1999 data and the model calibration.

2. Alternative Dissolved Oxygen Modeling - Task Code DOM

a) Task Goals – The water quality (DO) model will be used in conjunction with the field data to predict the potential effects for various depth alternatives of the Savannah Harbor Expansion Project on DO in the Harbor. A plan will be developed and used to conduct the modeling of project effects. The plan will specify the input and output criteria for various model runs.

b) Project Need – The model will be utilized to quantify the deepening effects upon the physical and chemical parameters of concern. These effects will then be correlated to quantify impacts to biological and ecological resources within the Lower Savannah River. Modeling of mitigation alternatives and alternative depths will need to be performed and the levels of impact evaluated and quantified.

c) Scope – Upon acceptance of the water quality model calibration, the model will be utilized to compare the effects of various alternatives upon the physical and chemical parameters of concern. Each alternative will need to be simulated under the same input conditions to compare the levels of impact. The number and nature of the model simulations will be determined through an iterative process designed to focus towards a smaller set of the most likely alternatives.

In applying the modeling tools for the evaluation of impacts to natural resources, the determination of the critical conditions, i.e. those conditions under which the effects of the deepening will be felt most severely, will be necessary. The matrix of critical condition scenarios to be evaluated will be developed through the following steps:

- Identification of the parameters to be included in the critical conditions matrix
- Quantification of the historic range of conditions for each of the parameters
- Utilize the models/tools in conjunction with historic data to identify what combinations of conditions reflect the worst case scenario
- Develop the matrix of model runs for effects evaluations

The development of the model effects run matrices should be completed by coordination with a working technical group from the resource agencies.

d) Deliverables – A report of the methodology, assumptions, inputs and results of the model applications will be prepared.

3. Freshwater Marsh Succession Evaluation - Task Code SEGFM

a) Task Goals – The goals of this task are to (1) update and expand the existing information regarding the distribution of plant species within the tidal fresh water and brackish marshes of the Savannah National Wildlife Refuge, and (2) continue to define the environmental factors that determine the plant distributions. These environmental factors include salinity, hydroperiod, marsh elevations, and sediment characteristics. The work described in the following scope is oriented toward collection of field data concurrent with the intensive salinity study being conducted during summer, 1999. The data will be used to plan the development of marsh succession models, which will provide predictive capability regarding the future marsh vegetation distribution within the Savannah National Wildlife Refuge.

b) Project Need – Based on input received from the Tier I EIS, an improved methodology for the application of salinity modeling results to an assessment of salinity impacts on the tidal fresh water marshes of the Refuge was developed. This impact assessment will need to include the development and use of a set of hierarchically nested spatial marsh succession models as a predictive tool to assess salinity impacts under various design alternatives. Development of the methodology to be used in determining impacts requires an accurate assessment of current conditions within the Refuge marshes.

A number of salinity meters and data loggers installed within the Savannah National Wildlife Refuge (SNWR) and adjacent marshes will remain in place for approximately 2 months. The data collected by this field effort will be used to study salinity dynamics within the waters of the Savannah River and the adjacent Refuge marshes. Evaluating the potential impacts of salinity changes and other hydrologic parameters on the tidal freshwater marshes of the Refuge will be the ultimate focus of the study.

c) Scope – This task will provide data on plant distributions and selected physical parameters that may determine those distributions. The proposed scope calls for field sampling during both the early summer and late summer growing season. In general, the scope includes establishing additional study sites within the fresh water and brackish marshes, updating the plant distribution data and mapping, and beginning a characterization of the variability in marsh sediments within the Refuge.

i) Establish Additional Study Sites – Based on the results of the two previous studies conducted on the Refuge (Pearlstine et al, 1990 and Applied Technology and Management, Inc., 1997), it is proposed that a combined study be initiated that includes establishment of additional study sites. The additional sites would be set-up using the methodology of Pearlstine et al, 1990 and include 6 transects with an array of 24 shallow wells for monitoring of interstitial salinity. A total of 6 additional sites are proposed and would fill spatial gaps in the salinity gradient not addressed in the previous studies. The additional sites would include 3 additional sites on Argyle Island, 2 sites on Ursla Island, and 1 site on Middle River Island. DR. W. Kitchens in coordination with ATM will determine the final locations. The sites will be referred to as the transect sites and will augment the 4 original sites established by Pearlstine et al, 1990. Note that the transect sites are in addition to the 8 quadrats established by ATM during their 1997 study. These 8 quadrats will be referred to as the quadrat sites. ATM will establish 4 additional quadrats that will coincide with 4 of the new transect sites.

ii) Salinity Data Loggers at 10 Marsh Locations – As part of the salinity monitoring study being conducted during the summer of 1999 under SEGP313, Marsh Salinity Field Data Collection, a salinity data logger will be placed in a shallow well within each of the 10 transect sites. The shallow wells will be located and installed in relation to the monitoring sites described in section 3.1. Interstitial salinity will be monitored for the duration of the salinity study.

iii) Update Quantitative Vegetation and Interstitial Salinity Distribution Data – All the transect sites and quadrat sites will be sampled for vegetative composition and interstitial salinity as soon as possible. This will allow the early summer seasonality characteristic of tidal fresh water marshes to be captured within the data set concurrent with the intensive salinity study. At each transect site, interstitial salinity will be monitored within each of the 24 shallow wells. In addition, vegetation within sample quadrats will be harvested for measurement of aboveground biomass on a per species basis. Vegetation within the quadrat will be sampled for species frequency and percent cover as was done previously (ATM, 1997). Harvest for biomass will also be conducted at 3 locations within each of the quadrats. Interstitial salinity will also be measured within each of the quadrat sites. Marsh elevations within study sites will be determined using GPS methodology as discussed below.

iv) Update Vegetation Mapping – This task will update the vegetation mapping for the Refuge. An updated map is essential for 2 purposes: (1) an up-to-date assessment of the extent of vegetation recovery after removal of the tide gate, and (2) the baseline within for application of a spatially based marsh succession model. The mapping update will include the following subtasks:

(a) Helicopter Reconnaissance – A helicopter will be used to provide an initial overview of the marsh study area. Each of the transect and quadrat sites will be observed from the air.

(b) Establish GPS Control Network – Integral to the mapping effort and eventually to the marsh succession model is accurate determination of marsh elevations. Determination of marsh elevations will require use of a survey grade GPS. This type of GPS unit is capable of providing elevation data accurate to within 2 cm. Attaining this accuracy requires calibration to existing horizontal and vertical control monuments. This task will establish a GPS control network tied to the local National Geodetic Survey network, as well as the U.S. Army Corps of Engineers benchmarks established in the late 1980's for the previous marsh study. The control network calibration only needs to be conducted once. Once the GPS is calibrated to the control network it can be used at any time or location within the limits of the control. Use of survey grade GPS requires the use of a portable radio base station set up over a fixed monument of known x,y,z coordinates. It is proposed that this permanent monument be established at a protected location at the Fish and Wildlife Service dock facility on the Back River. This monument will consist of a concrete post capped with a bronze disk and will be set into the ground with its top at ground level.

(c) Contract Aerial Photography – Growing season aerial photography of the Refuge will be contracted. These photos will provide the most detailed aerial photography available for the Refuge since 1981. This photography will include infrared, true-color, and panchromatic film flown at both 1:12,000 and 1:24,000 scale. Aerial targets will be placed prior to the photo flights to allow preparation of orthophoto mosaics of the 1:24,000 scale photos. These orthophotos will be converted to digital format on CD-ROM for use by the project team in GIS applications. The air survey contractor will also use the 1:12,000 scale aerials to photogrammetrically compile a map of the intricate tidal creek network that intersperses the marsh. This creek network is the fundamental mechanism for flooding the marshes during high tide and has a strong influence on sediment distributions within the Refuge marshes. The tidal creek map will be used as a GIS data layer subsequently model development.

(d) Acquire Current Satellite Imagery – Recent SPOT4 infrared and panchromatic satellite imagery that represents the early and late summer growing seasons will be obtained. These images will form the base of the vegetation maps. Classification of the images will be accomplished through image processing techniques keyed to field data and the aerial photographs discussed above. The imagery will be contrasted with pre-tide gate and post-tide gate imagery for change detection analysis.

(e) Digital Videography – Digital videography is a technique for obtaining high resolution digital images from an airplane mounted camera. The camera is tied to a GPS unit that allows precise positioning and will be used to obtain detailed digital imagery along each transect in each study area. The effort will focus on boundary delineations between marsh types and dynamics of boundary changes. This work will provide baseline data on the feasibility of using this technique to conduct routine monitoring of vegetation study sites.

(f) Combined Formal Accuracy Assessment and Sediment/Marsh Variability Reconnaissance – The reliability of vegetation maps produced through remote sensing methods is contingent upon the results of a formal accuracy assessment. Such an accuracy assessment is conducted by field inspection and examination of detailed aerial photography of randomly selected locations that represent the variability of vegetation signatures within the marsh. The results of an accuracy assessment are presented in a contingency table that provides a quantitative estimate of the overall accuracy of the map as well as the individual signatures. Locations of field control sites will be determined from the initial map classifications. These locations will be determined in the field using GPS navigation. At each field site a vegetation list will be prepared for comparison with the mapped classification for that point. In addition, the interstitial salinity will be determined, a marsh elevation obtained with the GPS, and observations made regarding the characteristics of the sediment substrate. Sediment samples will also be collected in accordance with the methodology discussed below. The results of the accuracy assessment will be utilized in finalizing the vegetation map.

v) Sediment Characterization Study – Concurrent with the vegetative sampling to be compiled for each of the transect and quadrat sites, data regarding sediment characteristics will also be compiled. One of the interesting observations that came from the 1997 marsh study was that a substantial acreage of marsh north of the Houlihan Bridge exists as floating mats of vegetation. These marshes consist of dense mats of intertwined plant roots that float on an underlying pool of water or very unconsolidated, low bulk-density sediments. Because the vegetation mats are floating, they can rise and fall with the tide. This ability to ride with the tide level means that many plants growing in the mat are rarely flooded and therefore the mat can support a plant assemblage that would otherwise be intolerant of flooding. Some portions of these floating marshes were found to have the highest plant diversities of any marshes within the study area.

The fact that the floating vegetation mats lie on pools of water or fluidized sediments means that the salinity dynamics in these areas are potentially much different than other areas of the Refuge where the vegetation is rooted in more consolidated substrate.

Observations of substrate characteristics will be made at each sample site, including sites sampled as part of the accuracy assessment. Observations will be made regarding the presence or absence of floating mat. For areas in which floating mat is present, the depth of the underlying sediments will be determined by sounding with a rod. For marsh areas with more consolidated sediments, interstitial salinity will be recorded after installing a shallow well. At each of the established well locations at the transect sites (240 wells total), sediment cores of the top 10 cm of sediment will be collected for later analysis. Laboratory analysis of sediment samples will include determination of percent sand, silt, and clay, percent organic matter, total dissolved solids, bulk density, pH, total phosphorus, total nitrogen, sodium, sulfate, magnesium, calcium, and potassium.

In addition to the field reconnaissance, an additional analytical technique will be evaluated for its applicability in mapping sediment variability within the refuge marshes. The differences in water content of the different types of marsh sediments should be physically manifested as differences in temperature. These temperature differences would be a reflection of the differences in heat content of the underlying water. Large volumes of pooled water, such as might be present under mats of floating vegetation, will change temperature more slowly than the surface of more consolidated marsh sediments, especially those that may be exposed at low tide. Therefore, different areas of the marsh may have different temperatures as a result of the water content of the underlying sediments. The LANDSAT remote sensing satellite includes a thermal band that detects differences in temperature of objects on the ground. A LANDSAT image taken under the appropriate conditions will be used in an effort to add additional resolution to the marsh sediment investigation. The LANDSAT thermal band has a 120 meter spatial resolution. If this somewhat coarse resolution does not provide satisfactory results, an airborne sensor may be used if feasible.

vi) Literature Search – Concurrent with the field data collection effort, there will be an ongoing literature search and review of existing data on the individual plant species that make up the plant assemblages of the study marshes. Examples of typical data include any literature values for salinity tolerances, nutrient uptake rates, photosynthetic production rates, typical standing biomass, size, habit (e.g., graminoid or herbaceous), reproductive strategies (annual or perennial, seeds or rhizomes), and photosynthetic pathways (i.e., C4 versus C3). This information will be compiled into a database for use in subsequent phases of the project. It is necessary to compile this information at this point in the project so that it can help focus discussions on the types of data that will have to be collected in upcoming field studies. This information will also serve to focus upcoming discussions regarding vegetation modeling methodology.

d) Deliverables – The deliverable for this task shall be a comprehensive data report containing all data collected during the study.

D. Tidal Wetland Study - Task Code TWS

1. Tidal Wetland Study – ATM activities - Task Code TWSA

a) Task Goals – The goals of this task are to (1) update and expand the existing information regarding the distribution of plant species within the tidal fresh water and brackish marshes of the Savannah National Wildlife Refuge, and (2) continue to define the environmental factors that determine the plant distributions. These environmental factors include salinity, hydroperiod, marsh elevations, and sediment characteristics. The data will be used to develop the vegetation succession models that will in turn provide a predictive capability regarding the future vegetation distribution within the wetlands of the Refuge and adjacent areas of the harbor.

b) Project Need – Based on input received from the Tier I EIS, an improved methodology for the application of salinity modeling results to an assessment of salinity impacts on the tidal fresh water marshes of the Refuge will be developed. This impact assessment will need to include the development and use of a set of hierarchically nested spatial tidal freshwater wetland succession models as a predictive tool to assess salinity impacts under various design alternatives. Development of the methodology to be used in determining impacts requires an accurate assessment of current conditions within the Refuge marshes. The data collected under the Proposed Scope outlined below will form the scientific basis for the spatial model prediction tool.

c) Scope – This scope will continue to build the plant distribution database and provide a comprehensive study of physical, chemical, and biotic factors that control plant distributions within the Refuge. As discussed above, the Proposed Scope was developed as a cooperative effort between the FWS and ATM. These tasks must be completed in conjunction with those tasks detailed in TASK SEGFM1B.

i) Continued Vegetation Monitoring – This task will provide for continued monitoring of the 10 quadrats established by ATM during the 1997 study, as well as collection of data on additional Rapid Assessment Plots (RAP). Quadrat data will be collected during both the early and late growing season.

ii) Water Level Study – This task will provide detailed data on hydrologic regimes within the specific vegetation associations identified through vegetation monitoring and mapping. Water level monitoring instrumentation will be installed at chosen locations to determine hydrologic regimes within distinct vegetation association. In addition, the instrumentation will be used to determine to what extent the floating vegetation mats rise and fall with the tide. The instrumentation will be moved to various locations for the duration of the project to cover the range of vegetation associations found within the project area. For subsequent use in the marsh succession model, the water level data will be related to marsh surface elevations as determined by GPS survey.

iii) Marsh Topography Survey – A key component of the spatial aspect of the marsh succession model will be marsh topography. Survey grade elevations will be made at each of the 10 FWS vegetation monitoring sites along the floodplain. These marsh elevations will be tied to the results of the water level study to define hydrologic signatures. The topographic survey will be conducted using GPS survey equipment. A permanent GPS base station control point has already been installed at a central location to facilitate the marsh survey.

iv) Sediment Characterization/Mapping – The data to date strongly indicate that vegetation distribution is heavily influenced by sediment characteristics. Two primary sediment characteristics will be investigated in this task: (1) the locations of sediments that support floating vegetation mats, and (2) the locations of sediments that support the production of hydrogen sulfide gas or methane gas. Some investigators hypothesize that floating vegetation mats are able to support relatively high plant diversities because, since they float, they are flooded less often than plants that are rooted into a firm substrate. The marshes of highest plant diversity within the study area exist as floating vegetation mats. This task will map the areas of floating mats for incorporation into the marsh succession model. Field mapping will be conducted in conjunction with collection of Rapid Assessment Plot data and other ongoing fieldwork. Ground penetrating radar (GPR) may be used to assist in mapping substrate types in selected locations. GPR data will be augmented and verified by extraction of sediment cores. In addition, production of hydrogen sulfide or methane gas may be a very sensitive indicator of areas that are receiving inputs of saline water during incoming tides. This task will also provide for collection of sediment samples at various locations throughout the study area. These samples will be analyzed in the lab for their potential for producing either hydrogen sulfide or methane gas and assessed for their contribution to production of floating mats.

d) Deliverables – The deliverable for this task will be a final data report that incorporates both the data collected under this task as well as the data collected by the FWS under SEGFM1B.

2. Tidal Wetland Study – USFWS activities - Task Code TWSU

a) Task Goals – The goals of this task are to (1) update and expand the existing information regarding the distribution of plant species within the tidal fresh water and brackish marshes of the Savannah National Wildlife Refuge, and (2) continue to define the environmental factors that determine the plant distributions. These environmental factors include salinity, hydroperiod, marsh elevations, and sediment characteristics. The data will be used to develop the vegetation succession models that will in turn provide a predictive capability regarding the future vegetation distribution within the wetlands of the Refuge and adjacent areas of the harbor.

b) Project Need – Based on input received from the Tier I EIS, an improved methodology for the application of salinity modeling results to an assessment of salinity impacts on the tidal fresh water marshes of the Refuge will be developed. This impact assessment will need to include the development and use of a set of hierarchically nested spatial tidal freshwater wetland succession models as a predictive tool to assess salinity impacts under various design alternatives. Development of the methodology to be used in determining impacts requires an accurate assessment of current conditions within and adjacent to the Refuge marshes. The data collected under the Proposed Scope outlined below will form the scientific basis for the spatial model prediction tool.

c) Scope – This scope will continue to build the plant distribution database and provide a comprehensive study of physical, chemical, and biotic factors that control plant distributions within the Refuge. As discussed above, the Proposed Scope was developed as a cooperative effort with the FWS. These tasks must be completed in conjunction with those tasks detailed in TASK SEGFM1A.

i) Continued Vegetation Monitoring – This task will provide for continued monitoring of all established vegetation study plots, including the 10 FWS transect areas (seven marsh sites, as per methods of Latham, 1991 and the three tidal forest sites using point-centered quarter transect techniques.) Transects and quadrats will be sampled during both the early and late growing season. Given the plant community dynamics in these marshes, it is also necessary to establish an intensive monthly sampling regime at a representative transect in each of the seven FWS marsh transect sites to document temporal changes and provide a perspective for the seasonal comprehensive samplings and timeline sequences for subsequent succession models.

ii) Transplanting Experiments – In order to more directly define the relationship among the various community types within the gradient of marsh types comprising the Savannah National Wildlife Refuge and in-situ salinity regimes, it is necessary to conduct experimental reciprocal transplanting among the various communities and marsh types. This task is intended to translocate and transplant intact cores of plant/substrate units in such a fashion as to cross transplant within, between, and among tidal marsh types (fresh, intermediate and brackish) while documenting subsequent vegetation responses, if any over time. In addition to confirming or clarifying correlational results of the other field studies, this technique was found to be extremely valuable to previous studies (Pearlstine et al. 1990) for providing time-lines for vegetation responses as well as indications of ecological community structural changes due to hydrologic alterations. These core plots will be designed and the spatial protocol implemented by March 2000. The sites will be monitored semi-annually as per the above task.

iii) Continued Salinity Monitoring – Except for the salinity monitoring conducted during the summer of 1999, there has been an absence of any long-term salinity monitoring subsequent to the cessation in operation of the tide gate. However, even the summer 1999 monitoring did not capture seasonal or annual salinity dynamics in the marshes. Data regarding these dynamics are critical to defining the ecological functioning of the marsh. This task will continue the marsh salinity monitoring initiated during the summer of 1999 by permanently installing a YSI 6000 XLM salinity meter in each of the 10 permanent study plots.

iv) Salinity Spatial Synoptic – Salinity in the marsh substrates is one of the principal community structuring factors the tidal wetlands of the Savannah River. Meters in the ten transect sites (above) provide ideal information on the temporal dynamics of salinities at specific sites. To maximize the value of this information it is necessary to complement this long-term spatially limited information (10 sites) with short-term, spatially intense synoptic sampling (approximately 100 sites) to resolve spatial distribution of salinity across and up and down the floodplain gradient. This sampling would be conducted by grabbing samples at pre-selected grid-point locations across the wetland complex from a roving airboat outfitted with GPS navigation. It would be scheduled to co-incident with the 2 major wetland plant samplings that correspond to the early and late growth season time points.

v) Tidal Swamp Study (Gap Analysis) – The tree community structure at various sites within the floodplain is a reflection of past and historic hydrologic conditions. A tree "gap" study will be conducted within the tidal forested transect sites previously established and monitored for breeding bird surveys. The intent is to document the relationship between tree canopy species and the sapling/seedlings in the various regeneration layers. This analysis will distinguish how present hydrologic regimes may compare to the previous conditions under which the canopy trees were established. These sites are unlikely to occur on the transects proper and will require finding tree fall sites in the immediate vicinity of the transects or as proximal as feasible.

vi) Sediment Characterization/Mapping (Synoptic spatial analysis) – In addition to the sediment sampling initiated previously at each of the 10 FWS permanent study sites, a synoptic series of regularly grid-spaced sites will be sampled seasonally along the upstream/downstream gradient. These data will be used to create a substrate characterization set of GIS layers to define transition and breakpoint regions representing the spatial boundaries of marsh zones from fresh to subsaline conditions. This task is essential to developing a spatial characterization of marsh substrate types across the various gradients of hydroperiods, salinities, riverine inputs, and tidal influences (tidal subsidies). This information is essential to the implementation of spatially based vegetation succession modeling.

vii) Vegetation Change Analysis – This task will continue a study already initiated by the USFWS based on other sources of funding. The task will be based on analysis of aerial photography and satellite imagery to determine changes in vegetation signatures over time. A primary aspect of the analysis will focus on the changes in the shrub swamp located in the transition zone between the tidal forest and the tidal freshwater marsh. Some field observations have indicated that the shrub cover has been increasing in this area. Comparisons between historical imagery and current imagery will be made to confirm and quantitate this trend.

viii) Vegetative Succession Model Development Support – This task will consist of providing USFWS input into Task SEGFM2 to develop a vegetative succession model. These support services will include providing data from previous and on-going studies, review and analysis of data, assessment of modeling assumptions and inputs, and assistance in the development of correlations to be used in the model.

d) Deliverables – Monthly Status Reports. Status reports of ongoing activities will be submitted on a monthly basis. The status reports will be due the second Tuesday of each month following the start of this task and include a brief discussion of what activities were conducted during the preceding month, what activities are anticipated in the upcoming month, and an estimate of the percent completion of each task. These monthly status reports will include a brief discussion of the status of the vegetation change analysis.

Quarterly Data Reports/Final Report. Data reports will be submitted quarterly as specified in the schedule listed below. The data reports will consist of a tabulated compilation of all data collected to date under this task. Detailed material and methods will be included. The final data report will be a compilation of all the data and materials and methods. The final report will be incorporated into an overall data report.

Historic Data Report. All historic data from the Pearlstine et al 1990 study will be submitted by March 17, 2000. This data will consist of the raw data collected under the previous study including all interstitial salinity monitoring data, plant species lists, biomass measurements, topographic spot elevations, seed bank data, reciprocal transplant data, etc.

Vegetation Change Analysis Report. A complete report regarding the vegetation change analysis will be submitted. The report will include a listing of images used in the study, detailed materials and methods, and a detailed discussion of findings and any conclusions drawn from these findings.

3. Resource Utilization Studies - Task Code TWRU

a) Task Goals – This task will be used to determine the relative importance and habitat value of the various types of tidal wetlands within the project area. The project goal is to be able to compare the relative value to wildlife of tidal swamp, tidal freshwater marsh, and brackish marsh.

b) Project Need – One of the critical issues associated with conversion of fresh marshes to brackish or saline conditions is disruption of the ecological nursery function of these systems in support of both the estuarine and freshwater fisheries. There is a need for a study to determine the extent of this disruption. In addition to changes in fisheries functions, changes in the value of the freshwater wetlands for use by migratory birds is also expected. Indeed, conservation of tidal wetland resources in support of migratory bird populations was the seminal basis for the creation of Savannah National Wildlife Refuge and remains the principal objective of the Refuge. Given the past and potential habitat conversions associated with harbor development, the FWS has initiated a study of breeding bird usage throughout the various tidal wetland types spanning the salinity regimes along the Savannah River. The task proposed below will provide information critical to management and mitigation decision-making and is intended to interface with and complement the on-going FWS study.

Concomitant with the need to study migratory bird usage of the Refuge is the need to study the total production of seed and mast for wildlife. At this point in time no studies have comprehensively measured and compared the seed production along a gradient of marsh types spanning tidal fresh to tidal subsaline conditions in a river delta. It is important to document the total production of edible seeds and mast across the marsh gradients in order to assess impacts of marsh conversions to this critical wildlife value function of the Savannah marsh complex.

c) Scope

i) Nekton Study – In order to determine the nektonic usage of the various marsh types, replicate flume net traps (as per McIvor et al. 1989) will be placed in critical tidal exchange points between the dredged channel networks and the adjacent expansive intertidal marshes. The net traps will be set on the marsh surface-proper, situated transverse to specific topographic depressions where tidal flows tend to be confined and collected between the marshes and adjacent channels. The sides of the mouth of the traps will extend to the lower tidal elevation limit of the emergent vegetation to the upper limit of the high tide water surface elevation. Cod-end pieces will be attached variously to the ends of the trap to collect nekton entrained through the flume on the rise and fall of the tides. Flume traps will be established at selected points, as described above, in each of the three marsh types along the salinity gradient. These sites should occur in the proximity of established vegetative sampling transects.

Data obtained from the traps will be coordinated with other investigators sampling fish communities in the river and subtidal reaches of the canal network to determine what portion of the fish species pool occupy and use the marsh surface.

ii) Migratory Bird Study – Avian use of the four major tidal wetland types within the Savannah National Wildlife Refuge will be assessed seasonally. These types include tidal swamp forests, fresh-, intermediate-, and brackish-marshes. Study design, to be completed in March 2000, is intended to document avian use by fall and spring migrants, and selected over-wintering birds. The design will focus on both spatial and temporal use, incorporating replicate surveys to ensure statistical validity. Sampling will begin in the spring of 2000 and run through the winter of 2001. Sampling methods will include point counts, mist netting and response to call recordings. Only birds using the habitats examined will be recorded, flyovers will not be included in the survey results. Sampling times will be centered on peak migration times, the last week of September for fall migration and the first week of May for spring migration. Winter sampling will be from December through March.

iii) Seed Production Study – Study sites will be set up in major vegetative communities in each of the 3 marsh types (fresh, intermediate, and brackish). Within each site, key edible seed producing species will be monitored for seasonal phenological development. Individual plants of each of the selected species will be tagged and carefully monitored through the season for flowering event timing and intensity. Seeds will be carefully counted on the flowering heads of each individually tagged stem. The intent is to monitor numbers and biomass of ripe seeds cumulatively produced over the season for each tagged stem. This is turn will be translated into aerial production within the species stands and communities by using percent cover occupied by the key species in each type.

d) Deliverables – Monthly Status Reports. Status reports of ongoing activities will be submitted on a monthly basis. The status reports will be due the second Tuesday of each month following the start of this task and include a brief discussion of what activities were conducted during the preceding month, what activities are anticipated in the upcoming month, and an estimate of the percent completion of each task.

i) Quarterly Data Reports/Final Report. Data reports will be submitted quarterly as specified in the schedule listed below. The data reports will consist of a tabulated compilation of all data collected to date under this task. Detailed material and methods will be included. The final report will provide a detailed discussion of the comparative resource values of the study marshes with regard to nekton, migratory bird use, and seed production. The final report will include an appendix of all data collected under this task.

4. Develop Marsh Succession Model - Task Code MSM

a) Task Goals – The goals of this task are to integrate data collected under the field data collection tasks into wetland impact prediction model. This model will be a geographic information system (GIS)-based spatial model that will predict changes in wetland vegetation distribution caused by salinity and water level changes associated with harbor deepening. A further goal of the model will be to study potential long-term (50-year) changes in vegetation distribution resulting from sea level rise.

b) Project Need – Based on input received from the Tier I EIS, GPA is planning to develop an improved methodology for the application of salinity modeling results to an assessment of salinity impacts on the tidal freshwater wetlands of the Refuge. This impact assessment will need to include the development and use of a set of hierarchically nested spatial tidal freshwater wetland succession models as a predictive tool to assess salinity impacts under various design alternatives.

c) Scope – This scope will compile all data generated and incorporate it into a spatial tidal freshwater wetland impact prediction model. Development of the model will be a collaborative effort between the FWS and ATM. Development of the Tidal Wetland Succession Model will be ongoing for the duration of the project. The model will be a spatially based model, meaning that it will receive input and produce output in the form of maps as per Pearlstine et al. (1990). It will be designed to provide acreage calculations of marsh changes over time. The principle input variables of concern are spatial hydrologic parameters, including hydroperiod, timing, and salinity regimes either modeled or measured to reflect pre- and post-project conditions as well as substrate characteristics. The model will be calibrated using data generated from the field data collection tasks outlined above and verified against field data collected in the late-1980s during the time the tide gate was in operation.

Fundamental to any discussion of marsh succession is the availability and viability of seeds within the marsh sediments. This study will determine what seeds are found at what locations within the sediments of the study area and under what salinity conditions they will germinate and grow. This study will be conducted in a greenhouse using sediments collected from a number of locations within the study area. The study design will provide for salinity treatments ranging from fresh to brackish. In addition to the seed bank study, seeds will be collected from selected tree species. In a greenhouse-based study, the collected seeds will be germinated and growth rates assessed under different salinity treatments.

Another important component of model development will be the consideration of the affect of historic water level changes within the study area and future changes that may be expected. This task will be conducted by the hydrodynamic modeling group and will provide data regarding historic water levels in the study area. It is anticipated these data will be generated by both compilation and review of historic records and through modeling. An estimate of long-term sea level rise over the past 150 years and a prediction of continued rise for the next 50 years are to be produced. Water level predictions are to be accompanied by estimates of changes in salinity. Specific factors to be considered in this task are water level changes and discharge volumes associated with the construction the upstream dams and reservoirs, the affect of the tide gate on water levels (including the residual effect of the remaining concrete structure), and tidal surge and post-storm river discharges resulting from Hurricane David in 1979.

d) Deliverables – The deliverable for this task will be a working computer model. The model will be calibrated and verified as discussed above and ready for subsequent use in tidal freshwater wetland impact prediction and mitigation option assessment. A report documenting the development of the model will be submitted.

5. Marsh Succession Analysis - Task Code SEGFM3

a) Task Goals – Application of the Tidal Wetland Succession Model will be used to predict the future extent of marsh vegetation changes (succession) associated with various project depth and mitigation alternatives.

b) Project Need – The marsh succession analysis will be needed to determine the project impact (change in marsh vegetation) of various alternatives and the effectiveness of mitigation alternatives.

c) Scope – The marsh succession model will be a spatially based model, meaning that it will receive input and produce output in the form of maps. (1990). It will be designed to provide acreage calculations of marsh changes over time. The principle input variables of concern are spatial hydrologic parameters, including hydroperiod, timing, and salinity regimes either modeled or measured to reflect pre- and post-project conditions as well as substrate characteristics. The hydrodynamic and salinity model will be applied under a set of critical (controlling) conditions and linked to the marsh succession model to predict vegetation changes caused by the project alternatives.

d) Deliverables – A report of the methodology, assumptions, inputs and results of the model applications will be prepared.

6. Beach Erosion Study - Task Code BES

a) Task Goals – The project area is composed of a complex barrier and sea island system. Since the project area is located in a mesotidal region, the inlets in the area are tidally dominated (as opposed to wave dominated inlets). Therefore, analysis of the system will include assessment of both waves and currents. The analysis of waves and currents will be accomplished through the application of wave and hydrodynamic models. Additionally, the Savannah River entrance does not resemble a typical inlet system; the flows from the Savannah River entrance interact with the flows from Calibogue Sound to create a large, complex inlet system. Therefore, the minimum extent of the modeled area will include the region extending from Hilton Head Island to Tybee Island (which includes Calibogue Sound and New River, Wright River and Savannah River Inlets). The overall study area will meet the USACE's requirement that the study area extend 10 miles up and down the coastline from the Savannah River entrance.

In order to determine the potential impacts of the deepening project, the study will first establish an accurate description of the existing coastal processes in the study area. An analysis of the historic changes in the system will provide necessary information for establishing the existing conditions. Previous engineering modifications to the inlet system, which must be assessed, include a number of deepening projects, construction of entrance jetties, and construction of a submerged breakwater. Those modifications will be assessed together as a group to allow identification of the cumulative impacts of previous inlet modifications. After the existing (without project) conditions have been established, the study will proceed to assess the potential impacts of the deepening project. The study goals can be summarized as follows:

- Develop Numerical Models – Develop computer models to describe the waves and currents in the study area.
- Historical Analysis - Qualitatively and (to the practical extent) quantitatively define the historical bathymetry and shoreline changes that have occurred in the study area. Include the development of the federal navigation project and the construction

of the jetties at the mouth of the Savannah River. Qualitatively assess changes in mechanisms that control shoreline accretion/erosion: incident wave energy, currents, sediment supply, and shoreline hardening (e.g., seawalls, groin fields, etc.).

- Establish Existing Conditions – Use the computer models to describe the existing conditions that influence sediment transport in the area, including incident wave energy and currents. Use the modeling results and historic change analysis to develop a sediment budget for the study area.
- Determine Projected Deepening Impacts - Use the computer models to determine effects to the local wave and current conditions caused by the proposed channel deepening. Utilizing the projected effects to the wave and current conditions, quantify the potential impact of the proposed channel deepening. Any effects of the proposed deepening on the nearshore and inlet sediment budget will also be identified.

b) Project Need – The dynamic nature of the coastal environment has resulted in changes in the position of ocean shorelines and in the volume of nearshore submerged shoals throughout history. The observed changes over the past 150 years are the net result of the cumulative effects of natural processes and man-made alterations on the Savannah Harbor inlet and surrounding areas.

Changes in erosion along the Tybee Island shoreline may be caused by changes in the following factors: incident wave energy, currents, and sand supply. Since the proposed deepening could potentially affect each of the aforementioned factors, it is important to study the relationship between the navigation project and the local wave and current conditions, and their impact on adjacent shorelines. This proposed scope of study will address the historic and existing coastal processes that affect coastal erosion, and determine the potential impacts to Tybee Island caused by the deepening and expansion of the navigation project.

c) Scope

i) Development of Hydrodynamic Model – The sediment transport properties along the shoreline of Tybee Island (adjacent to the mouth of the Savannah River) are highly influenced by the local ebb and flood currents. The currents are driven by a 6 to 10 foot tide range, with the tidal wave propagating nearly 40 miles inland under low flow conditions in the Savannah River. These currents impact the incident wave conditions, as well as the sand exchange between the Savannah River and the significant offshore shoals. The offshore bathymetric features, including the seaward portions of the Savannah Harbor Navigation Channel, create a complex circulation pattern that must be understood and quantified to properly assess the sediment pathways at this inlet.

The state-of-the-art WQMAP hydrodynamic model for the Lower Savannah River will be applied. This model application accounts for all areas that presently influence the tidal prism. This includes the flooding and drying of the extensive marsh system in the upper reaches, and the progression of the tidal wave almost 40 miles inland from the mouth. The model has been calibrated and verified against extensive hydrodynamic data including multiple tidal, current, and flow measurement stations. The coverage area of this model will be expanded to include the areas offshore of Tybee Island and Hilton Head Island in order to quantify the complex circulation patterns in the study area. This model will allow for the quantification of the temporal and spatial circulation patterns that influence sediment transport.

The model will be calibrated to a minimum of 30 days of measured currents in the offshore area at a series of critical stations, as well as tidal stations. This will provide verification that the model is accurately simulating the phase and amplitude of the tides and currents. In addition, measurements of flows over a spring and neap tidal cycle will be taken within the Savannah River, and Calibogue Sound to verify that the model is accurately simulating the tidal prism passing into each of these systems. Once calibrated, the model will be utilized within the wave model to project the incident wave fields.

The WQMAP model will be a two-dimensional, vertically integrated application of the model. The weakness of this approach is that it will not provide a true three-dimensional representation of the current patterns in the study area. However, unlike the estuarine region in the Savannah River, the vertical current variations in the offshore region are not as important as the horizontal current patterns. Sacrificing vertical resolution of the modeled currents will allow greater model resolution in the horizontal plane. If necessary, bottom current velocities can be extrapolated from the two-dimensional model results.

ii) Determine the Existing Conditions – The existing conditions will be determined by first examining the historic evolution of the study area. Computer models will be used to examine the pre-navigation project and existing channel conditions. The results of the historic analysis and the computer modeling will provide the basis for the development of a sediment budget. To determine the "without project" condition (for purposes of an incremental analysis), the study will include proposed actions that are reasonably certain to occur in the project area. These actions may include beach renourishment projects, construction of a bird island off Turtle Island and navigation channel modifications.

In determining the existing conditions, it would be beneficial to determine the cause of the ongoing erosion of Tybee Island. However, it is unlikely that the historic erosion of Tybee Island can be attributed to a single factor and described by a simple cause-and-effect relationship. Ortel et. al[1] listed a number of factors to consider when evaluating the erosional problems at Tybee Island:

- Location and orientation of the island with respect to the dominant wave energy.
- Meteorological climate.
- Characteristics of the littoral materials.
- Impacts of human intervention, including shore protection devices and the navigation project.
- Rise in sea level.
- The history of shoreline and offshore changes.
- The effect of water levels and tidal currents.

Man-made projects may have also contributed to the erosion of Tybee Island. Human actions that have impacted shoreline changes along Tybee Island include:

- Beach nourishment projects.
- Construction of groins, seawalls, and breakwaters on and near the island.
- Construction of the Savannah River navigational jetties.
- Deepening of the Savannah River navigation channel.
- Maintenance dredging operations on the Savannah River navigation channel.
- Hydropower and flood control projects on the Savannah River.

[1] Ortel et. al postulate that the geographic location and orientation of Tybee Island has probably been responsible for a portion of its shore erosion. The island is a headland extending into the Atlantic Ocean and does not have much protection for wave energy.

- Changes in land usage along the Savannah River upstream of the harbor.

Considering that all of the above natural and anthropogenic factors have influenced the evolution of the Tybee Island shoreline to one degree or another, it is difficult to filter out the historic change due to only the federal navigation project. Any analysis that aims to determine the relationship between the navigation project and erosion on Tybee Island must consider the shoreline change that would have occurred in the absence of the project (i.e., the "background change"). While this study endeavors to establish the historic changes that have occurred to the study area and establish the existing conditions of the study area, the study is not designed to isolate the historic impact of the federal navigation project on the Tybee Island shoreline.

iii) Analysis of historical shoreline and bathymetry changes – Analysis of long-term shoreline changes of Tybee Island will be reviewed. The island-wide average erosion rate of Tybee Island will be compared with the historical erosion rates of nearby barrier islands that have experienced a similar wind and wave environment. These islands will be within Georgia and South Carolina, but outside the influence of the Savannah Harbor Navigation Project, and have a geographic orientation similar to that of Tybee Island.

Analysis of long-term changes in area wide ebb tidal shoal bathymetry will be performed through map-differencing techniques based upon digitized historical boat sheet data. This will require the conversion of historic maps to a common horizontal and vertical datum. Additionally, depths will be adjusted to account for sea level rise. Color graphics depicting isolines of depth change over time will be formulated. The analysis will also be used to provide volumetric changes over time of the various shoals in the study area.

iv) Model currents using a hydrodynamic model – The WQMAP hydrodynamic model will be utilized to model the nearshore currents in the study area for the pre-navigation and existing (without project) conditions. An 1855 hydrographic chart of the Savannah River pre-dates major changes to the harbor and will provide the pre-project bathymetry to input to the hydrodynamic model. Since the tidal cycle repeats every 19 years, the pre-navigation model will use the same tidal forcing that was used for the calibrated existing condition model. Additionally, the water levels in the pre-navigation model will be adjusted for sea level rise. This will provide an indication of likely current pathways that existed before development of the navigation project, as well as the current pathways in the existing condition.

v) Model incident wave energy – The pre-navigation project and existing project incident wave fields will be modeled using REF/DIF 1 Version 2.5 (Kirby and Dalrymple, 1994). REF/DIF 1 is a state-of-the-art weakly nonlinear combined refraction and diffraction wave model. The model will accurately propagate water waves over irregular bottom bathymetry and incorporate the processes of shoaling, refraction, energy dissipation and diffraction. Additionally, the REF/DIF1 incorporates the effects of wave breaking and wave-current interaction. However, REF/DIF1 will only provide steady-state results. That is, the results will show a "snap-shot" in time of the input conditions. Multiple model runs will be required to examine the wave field under various conditions.

Digitized historical boat sheet data will be used to develop the model grid over which the modeled waves will be refracted and diffracted. Input offshore wave conditions will utilize USACE's Wave Information Studies (WIS) hindcast data or historical wave data. Average and storm conditions (determined by their statistical significance, but at least the 10-, 50- and 100-year events) will be modeled. Since REF/DIF 1 is capable of modeling wave-current interaction, the current data developed by the WQMAP hydrodynamic model will be input to the wave model grid to assess combined wave-current interactions. Scenarios to include in the model runs will include high tide, mid ebb tide, mid flood tide, and low tide current fields for each incident wave field.

Specific emphasis will be placed on assessing the combined wave-current effects on the Tybee Island shoreline. The pre-navigation and existing incident wave energy along the Tybee Island shoreline will be compared by calculating the alongshore transport potential at the shoreline.

vi) Sand Supply – The historic maintenance dredging volumes along the entrance channel and the Jones/Oysterbed Island reach will be tabulated. The volumes of sands and fines will be determined, if the data is available from historic dredging records. Changes in maintenance dredging volumes after each deepening project will be determined. This task is dependent on the amount of data available from the USACE. Additionally, available sand grain size data collected for the GADNR/Skidaway sediment transport study, Tybee Island, Daufuskie Island and Hilton Head Island sand search projects, monitoring of the ODMDS site, and other studies will be used to map the sediment characteristics in the study area. Together with the historic analysis of the volumetric change of the various shoal features, these data will provide the basis to identify and assess changes to the sand sources and sand transport pathways in the study area.

Proper identification of the type of sediments removed from the entrance channel is critical to determining the effects of the entrance channel on the sediment budget. After review of the available sediment data, the necessity for additional sediment sampling along the entrance channel will be determined. If inadequate data is available, additional samples will be taken at a spacing of roughly 5,000 ft along the length of the entrance channel. This sampling would extend from Fields Cut (Station 27+000) to the outer end of the deepened entrance channel (Station -70+000B). The exact sampling locations would be determined upon examination of "Before" dredging surveys to ensure areas of typical shoaling are included.

vii) Sediment Budget – A sediment budget is a sediment transport volume balance for a selected segment of the coast. It is based on quantification of sediment transportation, erosion, and deposition for a given control volume. Usually, the sediment quantities are listed according to the sources, sinks, and processes causing the additions and subtractions. In particular, the volumetric changes at the ODMDS will be used to determine the accumulation of sediment at the site and will be compared with volumes of dredged materials from the channel.

Based on the data collected in the tasks identified above, a sediment budget for the existing condition will be developed for the Savannah River Entrance (including Jones/Oysterbed Island reach). Both the methodology recommended by Rosati and Kraus[1] as well as the "Family of Solutions" approach presented by Bodge[2] will be utilized to formulate the sediment budget.

viii) Incremental Impact of Deepening Project

(a) Currents – Using the previously developed hydrodynamic model, the existing (without project) navigation channel and post-deepening project scenarios will be modeled to assess the incremental impact of each project depth alternative on the study area currents.

(b) Incident Wave Energy – Using the previously developed wave model, existing and post-deepening scenarios will be modeled to assess the incremental impact of each project depth alternative on the study

[1] Rosati, J. D. and N. C. Kraus (1998). "Formulation of Sediment Budgets at Inlets ," Coatal Engineering Technical Note CETN IV-15, U.S. Army Research and Development Center, Vicksburg, MS.

[2] Bodge, K. R. (1999). "Inlet Impacts and Families of Solutions for Inlet Sediment Budgets." Proceedings, Coastal Sediments '99. American Society of Civil Engineers. Long Island, NY.

area shorelines. The current data developed by the hydrodynamic model for the existing and post-deepening scenarios will be input to the wave model. Average and storm conditions will be modeled. The alongshore transport potential will be computed along the Tybee Island shoreline for existing and post-deepening scenarios.

(c) Incremental Project Impact – An estimate of the incremental project impact will be determined based on the following: (1) changes to the incident wave energy, (2) changes to the inlet current patterns, and (3) changes to the critical sediment transport pathways. A sediment budget for the predicted post-deepening project condition will be developed for comparison purposes. The predicted net change in pre- and post-deepening sand budgets will be identified. This analysis will not include the effects of any placement of sediments excavated during construction of the Expansion Project. Analysis of those effects would be included in a separate task statement.

d) Deliverables – The deliverables for this task will include five interim reports and a final report:

- Compilation of historic data and analysis of bathymetry changes.
- Calibration of the hydrodynamic model.
- Hydrodynamic modeling results.
- Wave modeling results.
- Sediment budget results.
- Final report.

The final report will summarize the work performed and will include all assumptions, methodologies, and procedures used in the study. In addition, the final report will address the goals outlined, summarize the findings, and draw conclusions from this work task.

E. Fisheries Resource Investigations - Task Code FR1

1. Shortnose Sturgeon Evaluation - Task Code SEGSNS

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

2. Striped Bass Evaluation - Task Code SEGSB

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

3. Fisheries Committee Studies - Task Code FCS

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

F. Fisheries Resources Action Plan Execution - Task Code FRP

a) Task Goals – This task statement, developed under GPA Task FRAP, identifies the requirements for fulfilling the fisheries component of the Tier II Environmental Impact Study (EIS) for the Georgia Ports Authority (GPA) proposed deepening of the Savannah Harbor. More specifically, the tasks emanate from the requirement that GPA (1) develop a fisheries resources action plan; (2) respond to Tier I EIS comments; (3) review and monitor on-going fish studies; (4) update the fisheries resource characterizations needed for Tier II; and (5) coordination with resource agencies and other interested parties to ensure compliance with project requirements and identify/resolve issues of concern. Each of these subtasks is discussed below.

b) Project Need – This coordination effort will ensure compliance with NEPA, ESA and EFH requirements, which are needed for the Tier II EIS.

c) Scope

i) Task FR12- Develop fisheries resources action plan – develop a fisheries resources action plan to ensure regulatory compliance and describe coordination actions necessary to complete the Tier II EIS.

ii) Task FRAP1- Fisheries Resources Characterization

(a) Response to Regulatory, Reviewing Agencies and Public Interest Tier I EIS comments – The Tier I fisheries section of the EIS elicited numerous comments by reviewing agencies which have to be addressed. The goal is to review these comments, collate them and reduce them to a manageable set of responses that address the concerns identified in coordination with the resource agencies. The review is guided by the need to coalesce all concerns into a smaller, more focused set of issues, such as the development of evaluative criteria. In this way, on-going or proposed studies with unclear end points will be fit into the evaluation framework for project criteria development and decision-making.

(b) Review of Proposed Studies from Reviewing Agencies – The South Carolina Department of Natural Resources, Marine Resources Research Institute and the USGS Biological Resource Unit in conjunction with the Georgia Cooperative Fish and Wildlife Research Unit are studying the temporal and spatial distribution of estuarine dependent species in the Savannah River Estuary. Dr. Mark Collins of SCDNR has also started a separate study of spawning aggregations of sciaenid species in the Savannah Harbor. Tasks will be to (a) review these studies to monitor the results in order to develop criteria for measuring and evaluating project impacts; (b) present recommendations for modification or incorporation of these studies into the development of management strategies; (c) provide technical support and understanding of the estuarine dynamics and modeling process, as required; and (d) work with the designated principal investigator for each study conducted to provide focus on the project deliverables, which will be included in the Tier II EIS.

iii) Task FRAP2- Essential Fish Habitat (EFH) Consultation – Update Tier I Fisheries Resource Characterizations to comply with provisions of the “Essential Fish Habitat Conservation Mandate”. The entire project area has been designated as “Essential Fish Habitat”. This will require adding more fish species to the list of fisheries resources and doing literature searches to identify any impacts on specific resources of concern. The list will be defined after early consultation with the NMFS and other resource agencies. An EFH Assessment will be prepared to comply with the requirements referenced in EFH regulations. Coordination with the COE and NMFS will be required to determine the appropriate Federal consultation process, most likely the “Expanded” process, as described below. The South Atlantic Fisheries Management Council and other interested parties will be contacted to identify project concerns and newly developed information, such as Fishery Management Plans.

iv) Task FRAP3- Endangered Species Act Coordination – Coordinate and make required preparations related to Endangered Species Act, Section 7 Consultation with NMFS. A Shortnose Sturgeon study has been underway in the Savannah River and determinations have to be made as to how the research results will be used to address NMFS issues and concerns. EPA has also conducted resource surveys in the Harbor and laboratory testing of shortnose sturgeon in the development of criteria for a new dissolved oxygen water quality standard. Coordination with these natural resource agencies will be required to address the potential project impacts and agency concerns. Information affecting the use of the COE/NMFS Regional Agreement dealing with the potential impact of dredging activities on protected species of sea turtles, whales and manatees will be coordinated. The consultation process will be used to revise the Tier I BATES and evaluate mitigation alternatives.

d) Deliverables

2. Fish Characterization Activities - Task Code FR

a) Task Goals – Conduct the work needed to evaluate the natural resources to be impacted by the project.

b) Project Need – The EIS will have to adequately characterize any resources of concern and disclose the predicted project impacts on these resources. This is a short literature search to help characterize the migration habits of several species of anadromous fish, which were determined to be potentially impacted by the project. The information will be used by the PDT to help determine whether additional studies are needed.

3. Hurricane Surge Evaluation - Task Code HSE

a) Task Goals – Estimate the project effects on the storm surge amplitude in the harbor which may increase overland flooding.

b) Project Need

c) Scope – The modeling will use the Hugo storm surge hydrograph measured at the Customs House in Charleston Harbor to force the offshore boundary of the two-dimensional model. Since isolation of the effect of the channel deepening on the storm surge is of primary interest, it has been decided to not include additional freshwater inflow. The model will be used to simulate both the authorized channel depth as well as the maximum proposed channel depth (48 ft. project depth-Inner Harbor). The model results will be compared for both simulations and will be summarized as a plot of maximum flood elevation versus river mile.

d) Deliverables

4. Aquifer Effects Evaluation - Task Code AEE

a) Task Goals

i) Verify and supplement findings of previous studies on potential impacts to Floridan aquifer due to dredging.

b) Project Need

i) Analysis of potential impact to aquifer must be sufficient to meet federal and state requirements for project permitting.

c) Scope

i) Refine understanding of hydraulic properties (including head data) of Miocene confining unit above aquifer.

ii) Refine understanding of hydraulic properties and geometry of paleo channels.

iii) Refine understanding of salt water intrusion through Miocene confining unit.

iv) Refine understanding of potential change in rate of salt water intrusion due to removing confining unit/paleo channel material to proposed project depths.

v) Refine understanding of overall geologic framework.

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

i) Written report of analysis and conclusions

5. Impact evaluation and mitigation matrix development - Task Code IEMP

a) Task Goals

- Identify candidate mitigation actions
- Translate natural resources effects predicted by modeling into impacts

- Model and analyze mitigation candidate alternatives to determine resulting effects.
- Develop a matrix of impacts and candidate actions for each plan formulation alternative

b) Project Need – Detailed analysis of impacts for each plan formulation alternative is required by USACE regulation, NEPA under CEQ regulation, and the authorization of WRDA 1999. A mitigation plan for the selected project alternative is required.

c) Scope – As determined by the scope of study and projected impacts.

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

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G. Engineering & Analysis - Task Code DDP

1. River Hydraulic Modeling - Task Code EEHM

a) Task Goals – Simulate the hydraulic characteristics of the Savannah River post project

b) Project Need – Required by USACE engineering regulations whenever a major modification to the hydraulic characteristics of a river or waterway are modified.

c) Scope

d) Deliverables

2. Evaluation Of Advance Maintenance Features - Task Code

EEHM7

a) Task Goals – Utilizing the sedimentation and hydraulic model(s), evaluate the effect of deepening on annual maintenance requirements. Determine if the advance maintenance features of the current 42 ft. MLW navigation channel should be included in the selected channel configuration for a deeper channel.

b) Project Need

i) Current authorized channel has advanced maintenance features included. Features were constructed to reduce annual maintenance costs.

ii) Deeper channel may or may not require advance maintenance features be preserved as currently configured or in modified configuration (location or depth or cross-section). Assumption during Tier I work leading to Feasibility Study Report conclusions were that the features would be preserved as current configured.

c) Scope – Encompass the segments of the channel that currently contain advanced maintenance features. Evaluate the necessity, based on estimated annual maintenance costs and predicted sedimentation patterns for the selected project alternative, to include advance maintenance features.

The criteria for justification will be a comparison of estimated annual maintenance costs with and without the features. Significant reduction in annual maintenance costs is needed to justify the inclusion of advanced maintenance features.

If advanced maintenance features are justified by annual cost savings for maintenance of channel depth:

- Determine location, extent, configuration and design of such features.
- Evaluate the environmental effects such features may cause.
- Estimate cost of construction and mitigation.

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

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H. Engineering - Task Code EE

1. Ship Simulation Study - Task Code SS

a) Task Goals – This work will simulate the handling characteristics of ships transiting the river to determine the ability of pilots to safely maneuver the vessels.

b) Project Need – Simulation of ship handling in the modified channel is required by USACE regulation to ensure safe handling and confirm the channel design configuration.

c) Scope

i) Determine, i.e., select, the engineering design vessel to be used for the General Reevaluation Report and Tier II EIS on the project.

ii) Conduct validation phase. Validation is the process by which we insure that our model of the existing harbor is accurate. Modifications to the visual, ship, and environmental (current, wind, banks, etc) will be made as per pilot recommendations. The simulation will encompass the entire length of the existing 42' navigation channel. Two pilots will participate in validation. Simulation runs will be done with the participation of the Savannah River pilot organization.

iii) A design phase will be used to determine the run matrix for the formal testing program. Problems with the proposed, deepened channel will be identified and addressed. The simulation will simulate inbound and outbound ship handling for the engineering design vessel using the Tier I alternatives channel configuration. A number of two-way traffic runs will be simulated. Two-way simulations will be conducted with two Panamax containerships (existing condition), the S-class containership meeting a Panamax containership and with two S-class containerships meeting. Presently, Panamax containerships meet in the straight segments east of the bridge. They do meet in turns if necessary, but that is not preferred. Preliminary evaluations of widening the Long Island Range by 100 feet on the south will be evaluated during this time. Two pilots will participate in the design phase. Simulation runs will be done with the participation of the Savannah River pilot organization.

iv) The formal simulation program will be conducted on the proposed improved channel. The existing channel will also be simulated as a base with which to compare results from the plan channel. The test matrix will be developed during the design session and finalized prior to the formal program. Wave and Vertical Motion Study will be conducted as part of this phase. Results from the proposed condition will provide guidance for the following:

(a) Depth required for the loaded design ship to transit Entrance Channel in the wave conditions tested.

(b) Tidal restrictions (if necessary) for the design ship to transit the Entrance Channel.

v) A total of six pilots will participate in the formal simulation program. Simulation runs will be done with the participation of the Savannah River pilot organization.

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

2. Design Support - Task Code EEFD

a) Task Goals – Provide the design services incidental to analysis and plan formulation not otherwise covered by specific tasks.

b) Project Need – Throughout the plan formulation.

c) Scope

d) Deliverables – To be specified when needs are identified.

3. Evaluation Of Dredge Material Disposal - Task Code EEDM

a) Task Goals – Verify the conclusions of the Feasibility Study Report dredge material disposal analysis.

b) Project Need – Modifications in timing of construction and potential changes in confined disposal area capacity require this analysis.

c) Scope

i) Determine the amount of material to be dredged for each plan formulation alternative and the projected disposal capacity for construction.

ii) Evaluate the location, timing and extent of actions for disposal area maintenance resulting from the project construction.

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

4. Bank Stability Evaluation - Task Code EEBS

a) Task Goals – Determine effects of deeper channel configurations on river and channel bank stability.

b) Project Need – Analysis required by USACE Engineering Regulations for Deep Draft Navigation projects. In addition, significant concern has been expressed by private and non-governmental organizations over the potential effects of a deeper channel.

i) Private property owners (Blue Circle, International Paper, others)

ii) City of Savannah (Roussakis plaza)

c) Scope

i) Development of topographic survey and sampling plans for geotechnical evaluation of river and channel bank stability for the length of the navigation channel.

ii) Coordination with public of the final sampling plans.

iii) Execution of the survey and sampling plans.

iv) Laboratory analysis of the collected samples.

v) Channel and river bank stability analysis.

vi) Development of CAD design files delineating the areas affected by riverbank instabilities.

vii) Development of CAD design files delineating channel bank sloughing characteristics and properties likely to be affected by channel bank instability.

d) Deliverables

i) CAD design files to meet Real Estate evaluation requirements and public information dissemination.

ii) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

iii) Electronic copies of the CAD files and final report in native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iv) Hard copies of the final report shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

5. Dredged Material Usage Evaluation - Task Code EETS

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

6. Cost Estimating - Task Code EECE

a) Task Goals.

i) Provide the feasibility level construction cost estimates to be used in the NED evaluation

ii) Provide the detailed cost estimate required to be forwarded with decision documents for final review.

b) Project Need

i) Construction cost estimates are an integral part of the USACE NED plan selection process.

ii) A detailed cost estimate is required by USACE policy for the final review.

c) Scope.

i) Comparative-level cost estimates for each channel improvement alternative will be prepared. Project cost estimates will be prepared for the alternative combinations of channel dimensions and disposal options as described in the above scope of work. These estimates will include all Federal and non-Federal costs for dredging, disposal, navigation aids, engineering and design, construction management, and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R). An

MCACES cost estimate will be developed for the fully funded project as defined in the NED Plan.

(a) PED Cost Estimate – Input will be required from EN, Planning Division, Operations Division, and Real Estate Division. PED cost estimates will be developed for the project through the plans and specifications phase for inclusion in the Project Management Plan (PN2).

(b) Project Cost Estimate – Preliminary construction cost estimates will be prepared for approximately 60 harbor improvement alternatives. These alternatives consist of combinations of project segments, depths, project widths, and different potential dredged material disposal options. Alternative dredging estimates will be prepared using the Corps' Cost Engineering Dredge Estimating Program (CEDEP) spreadsheet based on quantities as discussed above. Operations Division will review alternative estimates for appropriate equipment, productivity and operational factors. For non-dredging work, rough order of magnitude (ROM) estimates will be prepared using spreadsheets. These spreadsheet estimates will be based on the escalated historical cost of similar projects.

(c) Operation and Maintenance (OMRR&R) Cost Estimates – OMRR&R estimates will be prepared in support of the NED plan. Coordination will be required with Operations Division.

(d) Baseline Fully Funded Cost Estimate – As part of this task a Construction Execution Plan will be developed to take into consideration construction contract size, phasing within each contract, and the sequencing of contracts. Coordination will be required with Operations Division, Construction Division, Planning Division, and the GPA. An MCACES fully funded cost estimate will be prepared taking into consideration the Construction Execution Plan.

ii) Independent Technical Review – This task includes attending the ITR conference and briefing the ITR team on the preparation of the estimates for the GRR. Responses to the ITR team's comments will be provided, and review comments incorporated in the Project Fully Funded Cost Estimate.

iii) Estimate construction costs to the level of detail prescribed for NED analysis procedures for each project alternative being considered in the final plan formulation decisions.

iv) Conduct a detailed construction cost estimate for construction planning.

d) Deliverables.

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

I. Environmental Support Tasks - Task Code ENE

1. Task Goals.

a) Conduct an evaluation of the sediment quality of the GPA project berth.

b) Conduct the hazardous, toxic, and radioactive waste screening.

2. Project Need.

a) Berth sediment quality is required of the non-federal interest(s) for evaluation of placement effects in confined disposal area(s).

b) HTRW screening is required by USACE regulation for new project material.

3. Scope.

a) Berth sediment quality will be done concurrent with the projectg sediment quality evaluation and will include the berth designated by GPA for the project NED benefits.

b) The HTRW screening will encompass the entirety of the navigation channel new material area(s).

4. Deliverables.

a) Written reports of analysis and conclusions.

i) Reports shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

ii) Reports shall be used as a source document for GRR/EIS documents(s).

b) Electronic copies of the final reports in native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

c) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

5. Sediment Quality Determination - Task Code SQ

a) Task Goals

i) Complete the sediment quality evaluation in detail deferred from the Tier I EIS.

b) Project Need – Section 404(b)(1) of the Clean Water Act (CWA) of 1972 requires that any proposed discharge of dredged or fill material into waters of the United States must be evaluated using the guidelines developed by the Administrator of the U.S. Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army. These guidelines can be found in Title 40, Part 230 of the Code of Federal Regulations.

c) Scope – As determined through coordination with the Savannah District and EPA.

d) Deliverables.

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

6. Real Estate - Task Code RE

a) Task Goals

i) Determine the real estate requirements for the construction of the selected project.

ii) Execute the necessary instruments granting permission for entry to property incident to investigation.

iii) Determine the instruments needed for project construction.

iv) Estimate the cost of real estate acquisition.

b) Project Need

i) Entry permissions are needed for investigation and analysis tasks.

ii) Real estate needs and costs are essential for the plan formulation process.

iii) Real estate instruments needed to provide for construction of the project need to be verified from the Feasibility Study.

c) Scope – As determined by geo-technical investigations.

d) Deliverables

i) Written report of analysis and conclusions.

(a) Report shall meet all appropriate USACE requirements for engineering analysis, including QA/QC requirements.

(b) Report shall be used as a source document for GRR/EIS documents(s).

ii) Electronic copies of the final report in its native and Acrobat format shall be provided to the PDT. The copies shall be optimized for electronic use and sharing via an Internet website.

iii) Hard copies shall be produced in sufficient volume to provide copies to all PDT members and have copies in reserve in sufficient quantity to fill expected requests for them, along with requirements for copies for Cooperating Agency and USACE review. Additional copies shall be provided, as demand requires.

7. Economic Reevaluation ER

a) Task Goals – The purpose of economic studies is to review the Feasibility Report (FR) Economic Analysis using the latest complete calendar year data to validate, verify, or modify, using the latest complete calendar year data, the information in the FR regarding water resources related problems, and identify and quantify the benefits and costs (monetary and non-monetary) of proposed solutions. The purpose is to facilitate the efficient allocation of society's scarce resources. Study documentation will include quantification and description of the impacts of alternative plans on the National Economic Development (NED) Account. Additionally, analysis of the Non-Federal Interest's financing capability will be performed. The results of economic studies will be presented in an appendix to the GRR, a summary of which will be included in the main body of the feasibility report and NEPA document. Tasks EEP1 through EEP10 and TRA 22 are all necessary elements of a cost - benefit analysis of the various alternatives arising from the plan formulation process. Evaluations will be conducted in compliance with the requirements of ER1105-2-100, revised. The tasks will also require regular coordination with the non-federal interest. Input from the plan formulation elements to identify the full range of alternatives to be subjected to preliminary analysis, together with preliminary cost data regarding those alternatives will be used in the screening of alternatives in accordance with Planning Guidance Letter (PGL) 97-10.

b) Project Need – The economic analysis of the Feasibility Study Report must be reviewed and validated, verified or modified as appropriate to reflect current information.

c) Scope – The scope of Tasks EEP4 and TRA22 will be comprised of the following:

i) Economic Analysis. The economic analysis will validate, verify, or modify, using the latest complete calendar year data, the information in the FR to result in a determination of:

- What goods carried into and out of the economic study area will be subject to an ocean voyage;
- What modes of transportation will carry those goods before and after its ocean voyage;
- What type of vessel will carry these goods during their ocean voyage;
- What quantities will be carried per unit of time; and,
- What it will cost to transport those goods by ocean carrier.

This information will be evaluated for the existing/future without project condition as well as each of the with project alternatives being evaluated: project depths of 42, 44, 46, and 48 feet, each project depth being evaluated at the design channel width. Thorough analysis of potential harbor/channel improvement options will be conducted during the GRR alternatives screening process.

ii) Economic Study Area – This will validate, verify, or modify, using the latest complete calendar year data, the information in the FR to result in a determination of the economic study area that is tributary to the proposed harbor and channel improvement project. The economic study area is seldom limited to the immediate port area. The inland trade region (hinterland) served by the port consists of a number of cargo hinterlands defined by the inland origins or destinations of specific commodities. Collectively, it's the cargo hinterlands of actual and potential commerce of the project port that define the economic study area.

iii) Types and Volumes of Commodity Flow – This analysis will validate, verify, or modify, using the latest complete calendar year data, the information in the FR to result in a determination of the following:

- Origins and destinations of import, export, and coastwise commodity shipments
- Commodity trade routes
- The transportation mode or modes by which commodities are carried to or from the port, including an evaluation of the diversity of commodities carried in container vessels
- The sizes and types of ocean vessels used for ocean transportation
- A description of the economic study area in terms of commodities (current and prospective), existing port development (including port infrastructure), local municipalities, local economy, and competing ports.
- A determination of the sensitivity of the total container trade projections to any individual commodity. To the extent that individual commodities do not significantly affect total projections of container trade, those commodities will be aggregated in any container projections.

Data sources will include Waterborne Commerce of the United States and interviews with harbor and facility representatives as well as any other relevant publications or knowledgeable industry personnel.

iv) Projections of Waterborne Commerce – Validate, verify, or modify, using the latest complete calendar year data, the information in the FR regarding commerce projections reflecting the potential use of the Waterway over the project life. The volume of harbor commerce will be projected on a commodity-by-commodity and trade-route-by-trade-route basis. Commerce projections will be based upon, but not limited to, any or a combination of the following methods: relating the traffic base to an index over time (e.g., general indices on a regional and industry basis constructed from OBERS projections), independent hinterland and resource availability studies supplemented by interviews of relevant shippers, carriers, port officials, commodity consultants and experts; and/or statistical analysis of historical flow patterns. Current guidance for risk and uncertainty/sensitivity analysis will be consulted and incorporated into projections of waterborne commerce.

v) Vessel Fleet Composition – Validate, verify, or modify, using the latest complete calendar year data, the information in the FR regarding historical, present and future vessel/fleet size and composition, comparison of which will result in determination of anticipated fleet changes over the period of analysis. Fleet composition will be considered according to trade route, type of commodity, and volume of traffic, capacity utilization and any port or canal restrictions. Data will be obtained from various sources, including but not limited to the U.S. Department of Transportation (Maritime Administration), trade journals, trade associations, shipbuilding companies, vessel operating companies port records and interviews with port/facility representatives. Current guidance for risk and uncertainty/sensitivity analysis will be consulted and incorporated into projections of fleet composition.

vi) Vessel Operating Costs – Commerce transportation costs will be determined using vessel operating costs published in the current Deep Draft Vessel Operating Cost Guidance Memorandum provided by the Corps of Engineers, Water Resources Support Center.

vii) Current Cost of Commodity Movements – The full waterborne leg origin-to-destination transportation costs for commodity movement will be estimated for the without and with project conditions. Estimated costs will include necessary handling, transfer, and storage, as well as any other accessory charges to the extent that with-project facilities exceed without-project facilities. Without project condition transportation costs will be based upon costs and conditions prevailing at the time of the study. With project condition transportation costs will reflect any efficiencies expected as a result of the alternatives evaluated (e.g., larger vessels, increased loads, reduction in time delays, more efficient landside facilities, etc.). Vessel movements will be simulated using a modified version of the Institute for Water Resources' IWR - NavSym model or other appropriate economic model. IWR-NavSym is a Monte Carlo (risk-based) waterway simulation model. It is used to assess the economic impacts of navigation improvements to the waterway being studied. By comparing different improvement scenarios (alternatives) with a baseline alternative (with6ut-project condition), the reduction in operating cost can be determined, and alternative navigation improvement plans can be assessed in a risk-based economic framework.

viii) Current Cost of Alternative Movements – The economic concept of substitution applies to production as well as to consumption. The essence of this task is to validate, verify, or modify, using the latest complete calendar year data, the information in the FR to identify and evaluate substitutes for this channel deepening/widening project (project alternatives to be evaluated are described in Task _____ - Economic Analysis). Such options may include alternative harbors, lightering, lightening/topping-off operations, traffic management, or use of other modes of transportation. This study task will be accomplished by drawing on knowledge of what is technically and practically possible in the field of ocean transportation. Information will be obtained through a search of appropriate literature and interviews with harbor users.

ix) Future Cost of Commodity Movements – This task will validate, verify, or modify, using the latest complete calendar year data, the information in the FR to result in an estimate of the relevant shipping costs during the period of analysis and future changes in fleet composition, port delays, and port capacity under without project conditions and for each harbor improvement alternative being evaluated.

x) Use of Harbor and Channel With and Without a Project – The purpose of this task is to validate, verify, or modify, using the latest complete calendar year data, the information in the FR to estimate harbor use over time, both without and with the project. Applicable data obtained for the establishment of existing conditions will be used as the foundation for this analysis. Data requirements include determination of the use of the harbor in terms of fleet composition, commodity flows, and transportation costs for without and with project conditions. Commodity transportation costs for each project alternative, for the life of the project, will be compared. Current guidance for risk and uncertainty and/or sensitivity analysis will be consulted and incorporated into analysis of this study task.

xi) National Economic Development Benefits – The primary source of NED benefits of a given deep draft navigation project is the difference between total transportation costs with the project and total transportation costs without the project (i.e., transportation costs avoided). The average annual cost of the investments that must be made in order to realize project benefits is subtracted from the average annual NED benefits in order to determine the given navigation project's net annual benefits. The NED plan is the project alternative with the highest net annual benefits. The benefit-to-cost ratio is computed by dividing annualized benefits by annualized costs for each alternative. As appropriate, NED benefits will validate, verify, or modify, using the latest complete calendar year data, the information in the FR to measure any or a combination of the following benefit categories:

(a) Cost Reduction Benefits - Cost reduction benefits will be calculated for vessel operations that meet any of the following:

- Same commodity, origin-destination, and harbor. Transportation benefits will be calculated as the difference between current and future transportation costs for the movement by the existing project (without project condition) and the cost with the proposed improvement (with project condition).
- Same Origin-Destination, different harbor. This cost reduction benefit category captures commerce that shifts to the harbor from other harbors due to the proposed improvements. Benefits are realized from the reduction in current and future transportation costs due to the alternatives analyzed.
- Same Commodity and Origin-destination, different mode. Transportation benefits are measured as the reduction in current and future, costs to the producer or shipper that result from commerce shifting from alternative modes of transportation to vessel due to the proposed harbor improvements.

(b) Shift of Origin Benefits. This benefit category will be calculated for commodities that have a change in their origin because of the proposed plan, but no change in destination. Benefits are measured as the reduction in total cost of transporting quantities with versus without the plan.

(c) Shift of Destination Benefits. Shift of destination benefits will be measured for commerce that is transported to a new destination due the proposed harbor improvements. NED benefits will be established as the difference in net revenues to producers with and without the project alternative.

(d) Induced movement Benefits - This benefit category will be estimated for operations where a commodity or additional quantities of a commodity are produced and consumed as a result of lower transportation costs resulting from harbor improvements.

(e) Safety Benefits - This benefit category will be estimated if there are reductions in vessel accidents realized due to the proposed harbor improvements.

xii) Average Annual Costs – Average annual equivalent construction costs, including interest during construction and any additional operation and maintenance costs above the current annual expenditure will be calculated. The analysis will include a clear statement of each assumption used in the estimate, a detailed rationale to support the assumption, and a discussion of the sensitivity of the estimate to alternative assumptions to be included in the Risk and Uncertainty Analysis portion of the GRR. The project first cost and period of construction will be obtained from Savannah District's Cost Estimating Section. The discount rate used for this analysis will be the discount rate established annually for the formulation and evaluation of plans for water and related land resources.

xiii) Socioeconomic Analysis – Existing social, economic and demographic conditions of Savannah, Chatham County, Georgia, Jasper County, South Carolina, and the specific project area (to the extent possible) will be documented for the GRR. The without and with project conditions will be defined and documented. Social impacts will be evaluated on the region, community, and groups within the zone of influence of the project. Impacts to be considered under the other social effects (OSE) account will include the following: income distribution; employment distribution; population distribution and composition; the fiscal condition of the state and local governments; the quality of community life; life, health, and safety factors; displacement; and long-term productivity. Impacts to minorities and low-income groups will also be evaluated and incorporated into the environmental justice analysis in the NEPA document. The extent of the documentation will reflect only that information needed by decision-makers to reach an informed choice among alternatives.

xiv) Regional Port Analysis – In considering alternatives to any recommended plan for a federal project, the proponent agency must examine all practicable alternatives to ensure a reasoned choice from among those alternatives and to ensure potential environmental impacts of practicable alternatives have been examined and disclosed. In its feasibility report to recommend channel deepening in Savannah Harbor, GPA, through its consultant Booz Allen & Hamilton, provided a multiport analysis which demonstrated that shipping through Savannah is economically competitive with shipping through other ports in the Southeast for products shipped from or destined to a broad hinterland. The feasibility report also showed that Savannah has the capability to expand to accommodate expected trade growth and to provide the intermodal facilities necessary to move the projected commerce through the port. During the scoping process for the Tier II EIS and General Reevaluation Report, the issue was raised of examining an alternative to consolidate shipments, particularly those carried on post-panamax container vessels, at one regional port and transshipping the containers to and from other existing ports, i.e., using the other existing ports as "feeder" ports. In theory, this alternative would continue to allow post-panamax vessels to trade in the United States, but would reduce the environmental impacts of deepening multiple harbors so each could accommodate post-panamax vessels. GPA did not present an evaluation of this alternative in its feasibility report for one simple reason. It was not considered a practicable alternative in that it would not meet the purpose and need of the project. However, the GRR and Tier II EIS will include an explicit evaluation of this alternative. It is anticipated that all the information necessary to make a reasoned evaluation of the practicability of the regional port alternative is readily available, can be compiled with relative ease, and can be analyzed in an orderly and efficient fashion to allow a reasoned assessment of its practicability. The following factors must be examined for each port in the South Atlantic range, including use of offshore ports and other transshipment options, to determine the practicability of this alternative. If this alternative is found to be not practicable, no further work would be required. If it is found to be practicable, additional development of a scope of work would be required.

(a) Describe existing and authorized channel depths in the Southeast and compare with design drafts of post-panamax vessels. Describe existing and future anticipated operational practices of post-panamax vessels for these ports. The purpose is to evaluate how the current and projected future design drafts of post-panamax vessels compare with the existing and soon to be dredged channel depths and how vessels plan to operate to take advantage of the channel conditions. Depending on the results of this comparison, one can make a judgment of whether selection of a regional port would reduce long-term dredging needs.

(b) Competitive transportation costs. Based on information from recent studies for channel deepening projects in the Southeast, compare transportation costs for a representative sample of origins to destinations through various ports.

(c) Based on information from recent reports, site visits and interviews, and other literature and available information, document current and projected future circumstances for the following factors at various ports in the region.

(i) Current throughput capacity.

(ii) Expansion capability.

(iii) Intermodal capability.

(iv) Landside secondary impacts.

(v) Potential Environmental impacts.

(d) Based on information from recent studies of channel deepening projects, from work of the Economic Working Group of the Stakeholders Evaluation Group, site visits and interviews, and from other relevant literature, describe the following factors for each potential regional port.

(i) Hinterland.

(ii) Regional trade growth.

(iii) Regional capacity.

(iv) Shipping line consolidation.

(e) Describe legal and institutional constraints of local, state, and federal governments and socio-economic impacts relating to the implementation of a regional port concept.

(f) Consolidate and compare all the above information and provide a conclusion as to the practicability of this alternative.

d) Deliverables – The deliverables for these tasks include an economic reevaluation report and the Economic Appendix to the GRR/Tier II EIS.

J. Cultural Resources - Task Code CR

1. Undisturbed Areas (Tier I) - Task Code CREU

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

2. Newly Identified Areas (Bank Stability Analysis) - Task Code CREN

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

3. Mitigation Features Survey - Task Code CREM

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

4. CSS Georgia Activities - Task Code CSSG

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

K. Compliance Documents Preparation & Review - Task Code CDPR

1. GRR & Tier II EIS Preparation - Task Code TRA

a) Task Goals – Prepare the document in draft form

b) Project Need – Mandated by USACE regulations and the WRDA 1999 authorization.

c) Scope

d) Deliverables

2. GRR & Tier II EIS Independent Technical Review - Task Code ITR

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

3. GRR & Tier II EIS Draft Document Review - Task Code TDR

a) Task Goals

b) Project Need

c) Scope

d) Deliverables

4. GRR & Tier II EIS Accompanying Documents Preparation - Task Code ADP
    a) Task Goals
    b) Project Need
    c) Scope
    d) Deliverables
5. Other State & Federal Compliance Actions - Task Code SCA
    a) Task Goals
    b) Project Need
    c) Scope
    d) Deliverables

L. Other Supporting Documents

1. Items of local cooperation - Task Code SCA
    a) Task Goals
    b) Project Need
    c) Scope
    d) Deliverables
2. Real Estate Acquisition
    a) Task Goals
    b) Project Need
    c) Scope
    d) Deliverables
3. Quality control
    a) Task Goals
    b) Project Need
    c) Scope
    d) Deliverables
4. Value engineering
    a) Task Goals
    b) Project Need

c) Scope
d) Deliverables

5. Environmental & Cultural Resources Concerns
a) Task Goals
b) Project Need
c) Scope
d) Deliverables

6. Safety & security
a) Task Goals
b) Project Need
c) Scope
d) Deliverables

7. Operation & maintenance
a) Task Goals
b) Project Need
c) Scope
d) Deliverables

8. Preliminary Project Cooperation Agreement (PCA)
a) Task Goals
b) Project Need
c) Scope
d) Deliverables

9. Financing plan
a) Task Goals
b) Project Need
c) Scope
d) Deliverables

10. Final Decision Documents Review And Approval - Task Code

FDRA

a) Task Goals
b) Project Need
c) Scope
d) Deliverables

11. Administrative Actions - Task Code AA

a) Task Goals
b) Project Need
c) Scope
d) Deliverables